SNAP PAC R-SERIES CONTROLLER USER'S GUIDE

SNAP-PAC-R1
SNAP-PAC-R2

Form 1595-070724—July, 2007

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Overview

Introduction

The affordable and compact SNAP PAC R-series programmable automation controllers provide powerful, real-time control and communication to meet your industrial control, monitoring, and data acquisition needs. As part of an Opto 22 input/output (I/O) system, one of these on-the-rack, industrially hardened units can handle multiple tasks involving digital and analog control, serial string handling, communication, and enterprise connectivity.

SNAP-PAC-R1 controller

Used with the included PAC Project Basic software suite (or PAC Project Professional, purchased separately), the Ethernet-based SNAP PAC R-series controller runs control programs written in Opto 22's PAC Control™ software to monitor and control a wide range of devices and equipment at the I/O level, or as a slave to a SNAP PAC S-series controller. SNAP PAC R-series controllers are well suited to original equipment manufacturers (OEMs), system integrators, and end-users in process control, discrete manufacturing, or hybrid industries and applications.

Two models of the SNAP PAC R-series controller are available:

- The **SNAP-PAC-R1** controls a mix of SNAP analog, digital (both standard and high-density), and serial modules. Full digital functions are available for up to 16 standard digital modules.
- The **SNAP-PAC-R2** also controls a mix of SNAP analog, standard and high-density digital, and serial modules. Digital functions are simplified; up to 16 standard digital modules can be used.

Built-in functions and comparisons of the SNAP-PAC-R1 and SNAP-PAC-R2 are shown in the table on page 37.

Ethernet Communication

SNAP PAC R-series controllers communicate over standard 10/100 Mbps Ethernet networks and can be attached to existing wired or wireless Ethernet networks. The controllers can also be used in an independent control network built with standard, off-the-shelf Ethernet hardware.

SNAP PAC R-series controllers include two 10/100 Mbps Ethernet interfaces for networking to Ethernet hosts and to other I/O units. These independent Ethernet ports have separate IP addresses that can be used with PAC Project™ Professional software to set up redundant network links to safeguard the availability and reliability of an I/O system, or to segment a control system's network from the enterprise LAN.

Serial Communication

SNAP PAC R-series controllers provide an RS-232 serial link to support Point-to-Point Protocol (PPP) modem connections—for creating TCP/IP networks over serial or PSTN (Public Switched Telephone Network) lines—as well as remote serial device communication.

The RS-232 serial interface supports either a modem connection using PPP or general-purpose communication with serial devices, allowing you to send and receive data from a serial device connected directly to the controller. For additional serial interfaces, you can add one or more SNAP serial communication modules on the rack.

I/O Mounting Racks

SNAP PAC R-series controllers must be connected to the appropriate rack to avoid damage to the controller. Both the SNAP-PAC-R1 and R2 are designed to work with SNAP PAC mounting racks, which are available with 4, 8, 12, or 16 positions for Opto 22 SNAP I/O modules.

SNAP I/O

The SNAP PAC R-series controllers support all SNAP I/O modules available on our website. SNAP digital I/O modules contain four input or output points, and SNAP high-density digital modules contain 16 or 32 input or output points.

The SNAP-PAC-R1 supports 4-channel digital modules with features such as high-speed counting. For the SNAP PAC-R2, only simple digital features are available. See the table on page 37 for specifics.

SNAP analog modules contain 2 to 32 points, depending on the module.

Software

SNAP PAC Controllers use Opto 22's **PAC Project** Microsoft® Windows®-compatible automation software for programming, human-machine-interface (HMI) development, and OPC connectivity. Two versions of PAC Project are available:

- **PAC Project Basic** includes PAC Control for developing control programs, PAC Display™ for creating operator interfaces, and PAC Manager™ configuration software.
- **PAC Project Professional** adds expanded versions of PAC ControlPAC Control and PAC Display plus OptoOPCServer™ software for exchanging data with OPC 2.0-compliant client software applications and OptoDataLink for exchanging SNAP PAC System data with databases (including Microsoft SQL Server, Microsoft Access, and MySQL), text files, and email systems).

PAC Control Basic is a graphical, flowchart-based programming tool for machine control and process applications. Using PAC Control, you create, download, and run strategies on a SNAP PAC controller. In addition to flowchart programming with subroutine capability, PAC Control includes a powerful, built-in scripting language based on C and other procedural languages. **PAC Control Professional** adds the ability to import legacy OptoControl strategies, support for older *mistic*™ serial I/O units, and support for the dual independent Ethernet ports on a SNAP PAC controller. A SNAP R-series controller simultaneously runs up to 16 PAC Control flowcharts, although the PAC Control strategy can actually contain a much larger number of flowcharts. The total number of flowcharts is limited only by the memory available for strategy storage.

PAC Display Basic is an intuitive HMI package for building operator interfaces, or *projects*, for communicating with a SNAP PAC controller. PAC Display offers a full-featured HMI including alarming, trending, and a built-in library of 3,000 industrial automation graphics. **PAC Display Professional** adds the ability to import projects created in OptoDisplay, part of the legacy Opto 22 FactoryFloor® software suite, and using redundant Ethernet communication links on SNAP PAC controllers. PAC Display Professional can also connect to Ethernet-based FactoryFloor controllers running OptoControl strategies.

OptoOPCServer™ is a fast, efficient OPC 2.0-compliant server for communicating with many Opto 22 products, including SNAP PAC controllers and other SNAP controllers running PAC Control strategies; SNAP Ethernet-based I/O units that use SNAP brains like the SNAP-B3000-ENET or SNAP-ENET-M64; and Ethernet-based FactoryFloor controllers running OptoControl strategies.

Using OptoOPCServer, you can consolidate data from all these Opto 22 systems into the OPC client software of your choice, such as third-party HMI and data acquisition packages, and custom software applications you create with tools such as Visual C++®.

PAC Manager™ is a utility application for assigning IP addresses to SNAP PAC controllers, reading or changing basic controller configuration, and more. PAC Manager is also used to configure additional Ethernet I/O units that communicate with the controller.

OptoDataLink is a software application that makes it easy to share data from SNAP PAC systems with commonly used databases, including Microsoft SQL Server, Microsoft Access, and MySQL, as well as text files. The I/O points and strategy variables already created in your PAC Control strategy are automatically available for OptoDataLink to use for data exchange.

Software Availability

PAC Project Basic is included with SNAP PAC controllers and is a free download from the Opto 22 website. PAC Project Professional is available for purchase on a CD with both Acrobat PDF format and printed documentation.

To get PAC Project Professional immediately, you can buy and download the software from the Opto 22 website at www.opto22.com; the CD and printed documentation will be shipped to you. You can also separately purchase PAC Control Professional, PAC Display Professional, OptoOPCServer, and OptoDataLink as needed. For additional information, see the PAC Project data sheet, Opto 22 form #1699.

About this Guide

This guide shows you how to install and use SNAP PAC R-series controllers. This guide assumes that you have some familiarity with TCP/IP and Ethernet networking. If you are not familiar with these subjects, we strongly suggest you consult commercially available resources to learn about them before attempting to install or use SNAP PAC R-series controllers.

If you are using Modbus/TCP for communicating with SNAP PAC R-series controllers, this guide assumes that you are already familiar with Modbus/TCP. See the *Modbus/TCP Protocol Guide,* form #1678.

The following sections are included in this user's guide:

Chapter 1, "Overview,"—information about the guide and how to reach Opto 22 Product Support.

Chapter 2, "Installation"—quick-start steps to get SNAP PAC R-series controllers up and running quickly.

Chapter 3, "System Information"—conceptual information on networking and communicating with SNAP PAC R-series controllers; descriptions of features, capabilities, and specifications for SNAP PAC R-series controllers.

Chapter 4, "Maintenance and Troubleshooting"—assigning and changing IP addresses, resetting the controller to factory defaults, upgrading firmware, and tips for resolving difficulties you may encounter while working with SNAP PAC R-series controllers.

Appendix A, "SNAP Mounting Racks and Power Supplies"— wiring diagram examples for assembling your SNAP PAC R-series controller, SNAP PAC rack and power supply.

Related Documentation

See the following documents for additional information:

For this information	See this guide	Form #
Configuring I/O points and system functions	*PAC Manager User's Guide*	1704
Designing flowchart-based control programs for the system	*PAC Control User's Guide*	1700
	PAC Control Command Reference	1701
	PAC Control Commands Quick Reference Card	1703

For this information	See this guide	Form #
Communicating with I/O units using OPC	*OptoOPCServer User's Guide*	1439
Communicating with I/O units using Modbus/TCP	*Modbus/TCP Protocol Guide*	1678
Programming your own applications for SNAP PAC R-series controllers using the OptoMMP Communication Toolkit (previously called the SNAP Ethernet I/O Driver Toolkit) or the OptoMMP memory-mapped protocol	*OptoMMP Protocol Guide*	1465

All of this documentation is on the CD that came with the controller; all forms are also available on our website (www.opto22.com) for downloading. The easiest way to find one is to search on the form number.

For Help

If you have problems installing or using SNAP PAC R-series controllers and cannot find the help you need in this guide or on our website, contact Opto 22 Product Support.

Phone: 800-TEK-OPTO (835-6786)
951-695-3080
(Hours are Monday through Friday, 7 a.m. to 5 p.m. Pacific Time)

Fax: 951-695-3017

Email: support@opto22.com

Opto 22 website: www.opto22.com

NOTE: Email messages and phone calls to Opto 22 Product Support are grouped together and answered in the order received.

When calling for technical support, be prepared to provide the following information about your system to the Product Support engineer:

- Software and version being used
- Controller firmware version
- PC configuration (type of processor, speed, memory, and operating system)
- A complete description of your hardware and operating systems, including:
  - loader and kernel versions for the controller, and date codes of controllers (available through PAC Manager). See page 45.
  - IP addresses and net masks for devices on the system
  - type of power supply
  - third-party devices installed (for example, barcode readers)
- Specific error messages seen.

Installation

If you already know how you will use the SNAP PAC R-series controller and want to get it running quickly, follow the sections in this chapter.

To learn about communication options and networking, start on page 17. Specifications are listed on page 32.

What You Will Need

You'll need the following items to install a SNAP PAC R-series controller:

- PC running Microsoft® Windows® 2000 or higher, with a 10/100 MB Ethernet adapter card, the TCP/IP protocol installed, and a valid IP address, on the same subnet as the controller. (For more information, see "Networking" on page 26.)
- Crossover cable (for direct connection to the PC), or an available connection to a standard 10BASE-T or 100BASE-TX Ethernet network.
- SNAP PAC R-series controller
- SNAP PAC mounting rack and SNAP I/O modules. Choose rack and modules based on your needs.
- A SNAP-PS5 or SNAP-PS5U power supply or other 5 VDC power supply (5.0 to 5.2 VDC at 4.0 A) applied to the rack. Additional power may be required for SNAP I/O modules and depends on the number and type of modules used. For more information, see "Determining Power Requirements" on page 57.

Installing Software

In your CD-ROM drive, insert the CD that came with the controller. The installation wizard should start automatically. If it doesn't, use Windows Explorer to navigate to your CD-ROM drive and then double-click setup.exe. Follow directions to install the software.

NOTE: If you run PAC Project applications in Microsoft Windows XP, make sure to use the Windows Classic theme. Otherwise, a Microsoft bug with how themes are handled may cause the system to crash.

Installing Hardware

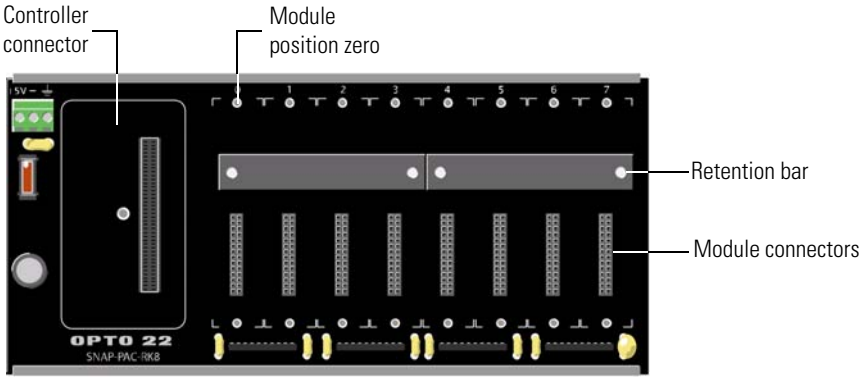
Assemble the rack and power supply according to the directions that came with them. For help with wiring, see the product data sheets, which are available on our website at www.opto22.com.

Installing Modules on the Rack

Modules snap into any position in the row of connectors on the SNAP PAC rack. Each module connector has a number. The SNAP-PAC-R1 supports full digital features on standard SNAP digital modules, including high-speed counting (up to 20 kHz, depending on the module), quadrature counters, time-proportional output (TPO), and pulse generation and measurement. For the SNAP-PAC-R2, digital features are limited to on/off status, input latching, and watchdog timer.

CAUTION: *Make sure you are using a SNAP PAC rack for your SNAP PAC R-series controller.* ***Using the wrong rack will severely damage the controller.***

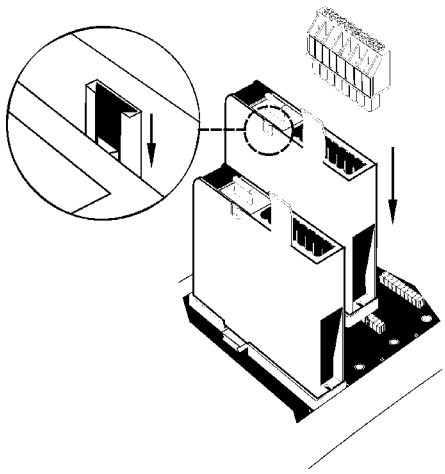
1. Place the rack so that the module connector numbers are right-side up, with zero on the left.



2. Position the module over the module connector, aligning the small slot at the base of the module with the retention bar on the rack.
3. With the module correctly aligned over the connector, push on the module to snap it into place.

   When positioning modules next to each other, be sure to align the male and female module keys (shown in the detailed view in the illustration at right) before snapping a module into position.

   Modules snap securely into place and require a special tool (provided) to remove them. To remove a module, see page 9.

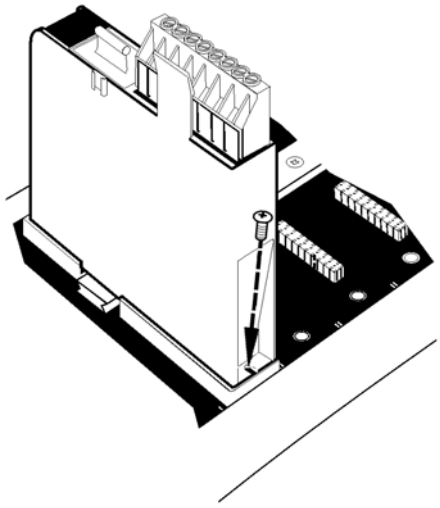


4. (Optional) As shown in the photo at right, use standard 4-40 x 1/4 truss-head Phillips hold-down screws to secure both sides of each module.

   CAUTION: *Do not over-tighten screws.*

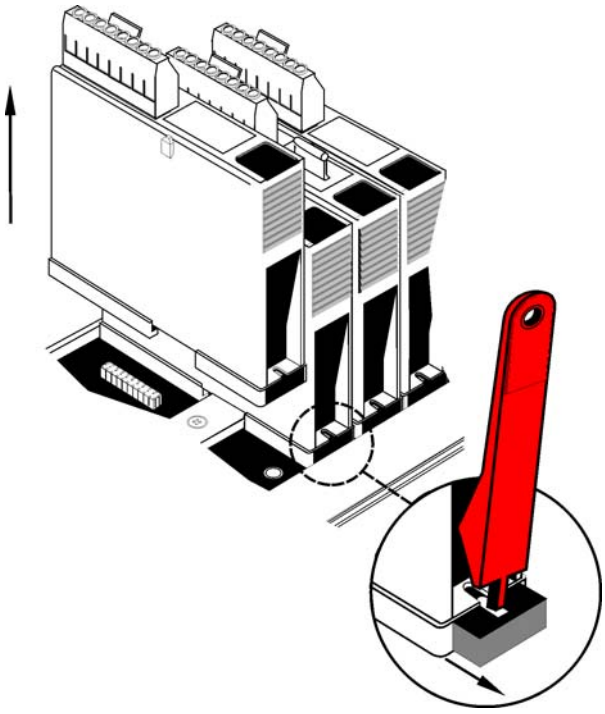
5. Plug the wiring connector into each module to attach modules to the devices they monitor.

   See the wiring diagrams in the module's data sheet.



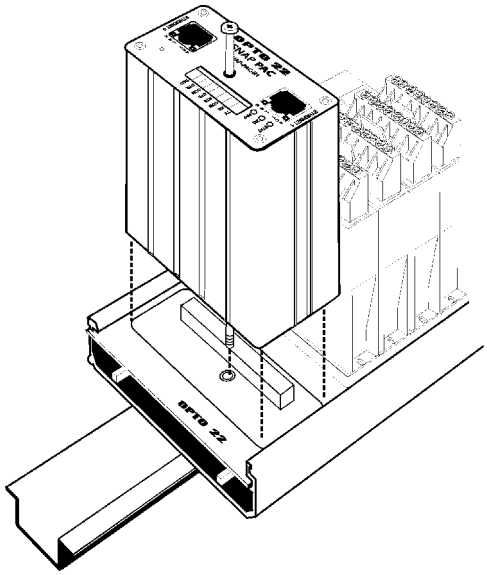
Removing a Module

1. If the modules are held in place with screws, remove them.
2. Holding the SNAP module tool (provided) as shown in the illustration at right, insert it into the notch at the base of the module.
3. Squeeze the module tool against the module to open the release latch, and pull straight up on the module to remove it.
4. Continue with "Installing the Controller" on page 10.



Installing the Controller

CAUTION: *Make sure you are using an SNAP PAC rack for your SNAP PAC R-series controller.* ***Using the wrong rack will severely damage the controller.***



1. Remove the controller from its packaging.
2. Turn off power to the rack assembly.
3. Align the controller connector with the mating connector on the mounting rack, as shown in the diagram at right.
4. Seat the controller onto the connector and use the hold-down screw to secure the controller in position. Do not overtighten.
5. Using Category 5 or superior solid unshielded twisted-pair cable, connect the controller in one of the following ways:
   - (Recommended for initial configuration) Connect to a PC directly, using an Ethernet crossover cable.
   - Connect to a standard 10BASE-T or 100BASE-TX Ethernet network that has a PC on the same subnet as the controller and does NOT have a Dynamic Host Configuration Protocol (DHCP) server.

   Maximum cable or segment length is 100 meters; minimum cable length is one meter. For more information on cables, see page 26.
6. **For controllers used with a modem:** Follow the steps in "Using PPP Over a Modem" on page 12.
7. **Before** turning on power to the rack, follow instructions in Opto 22 form #1704, the *PAC Manager User's Guide*, to assign an IP address to the controller. This guide is in Adobe Acrobat PDF format on the CD that came with the controller and is also available from our website, www.opto22.com.

What's Next?

To start configuring controllers and I/O points, see "Configuring I/O," below.

To learn more about SNAP PAC R-series controller capabilities and network options, see Chapter 3, "System Information."

To create PAC Control strategies to run on the controller, see the *PAC Control User's Guide* and the *PAC Control Command Reference*. Both are available in PDF format on the CD that came with the controller and on our website, www.opto22.com.

To work with the following items on the controller, see instructions in the *PAC Manager User's Guide*:

- File system and FTP

- Security settings
- Port and interface configuration

To use OLE for process control (OPC) with SNAP PAC R-series controllers, purchase OptoOPCServer and see Opto 22 form #1439, the *OptoOPCServer User's Guide*.

To communicate with controllers using Modbus/TCP, see the *Modbus/TCP Protocol Guide, form #1678*.

To program your own applications, see Opto 22 form #1465, the *OptoMMP Protocol Guide*.

Configuring I/O

No matter how you communicate with SNAP PAC R-series controllers, you will need to configure I/O points and controller features.

If you are *not* using PAC Control (Opto 22's flowchart-based control software), follow instructions in the *PAC Manager User's Guide* (Opto 22 form #1704).

If you are using PAC Control, I/O units and points must be configured to match the PAC Control strategy you will run. You can configure most controller features and point functions either in PAC Control or in PAC Manager.

In most cases, if you are already in PAC Control, configuration is easier there and you can use the loopback IP address for SNAP PAC R-series controllers controlling themselves. However, some functions cannot be configured in PAC Control.

If you use PAC Manager, you can save your configuration to a file, load it to multiple I/O units at once, and use it for referencing points in OPC. However, you cannot use the loopback address in PAC Manager.

Choose your configuration tool based on what you need to do:

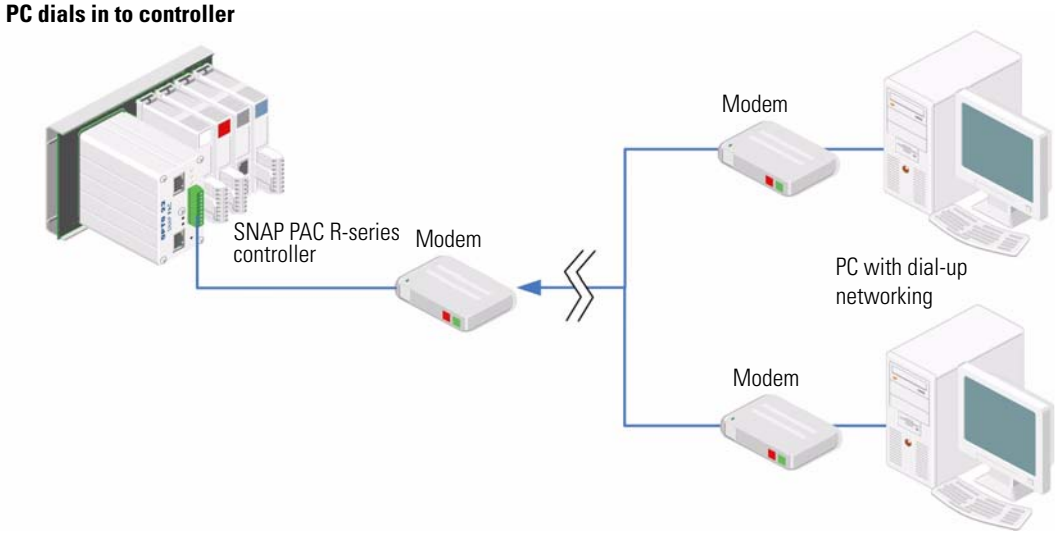
Use PAC Control for I/O configuration if…	Use PAC Manager for I/O configuration if…
• You have only one I/O unit or I/O unit configurations are different. • The strategy will run on I/O units that are controlling themselves using the loopback IP address (127.0.0.1). • You are using an Ethernet network for communications. • The strategy handles all logic; you are not also configuring events and reactions on I/O units.	• You have multiple I/O units whose configurations are exactly the same or similar. • You are using a modem connection (PPP) or SNMP. • You are using event messages or email. • You are configuring events and reactions on the I/O unit in addition to strategy logic. • You are using OPC to communicate with I/O units. • You are not using PAC Control.

Whichever tool you use for configuring I/O, be aware of the impact if you later change configuration. For example, if you configure I/O in PAC Manager, download the configuration file to I/O units, and then later add a point in PAC Control, remember that your configuration file doesn't contain that point.

Using PPP Over a Modem

Use the rest of this chapter only if you have SNAP PAC R-series controllers installed at remote locations or in other places where an Ethernet network is not available, and you are using modems to communicate between the controller and a PC. The modems use the point-to-point protocol (PPP) to communicate. You can set up communication so that the controller can dial in to a PC, so that PCs can dial into the controller, or both.

PC dials in to controller



NOTE: You can communicate with a SNAP PAC R-series controller using a modem and PPP at the same time you are communicating with the controller over an Ethernet network.

Here's how to set up PPP:

1. Use PAC Manager to assign an IP address to the SNAP SNAP PAC R-series controller, following the instructions in the *PAC Manager User's Guide*.
2. Follow steps in the next section to configure PPP.
3. Attach the modem to the system, following the steps below.
4. Set up Windows dial-up networking (page 13) on the PC.

Configuring PPP on the Controller

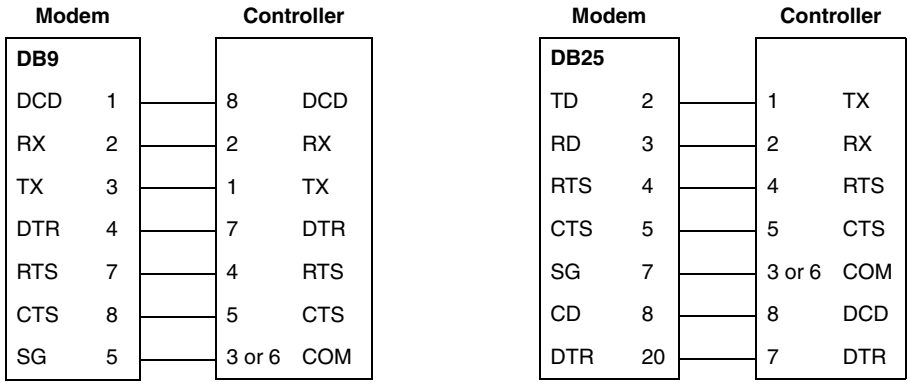
To configure PPP on the SNAP PAC R-series controller, see instructions in Opto 22 form #1704, the *PAC Manager User's Guide*. Also use this guide to assign an IP address to the Ethernet ports, configure points, and store configuration to flash.

Attaching the Modem to a SNAP PAC R-Series Controller

Once the controller and I/O points are configured and communication has been tested, follow these steps to attach the modem to the controller. To work properly with the controller, a modem must be able to store settings in non-volatile RAM (NVRAM) and default to those settings on reset.

IMPORTANT: *Any modem used with the controller must implement the Carrier Detect (CD) signal or use a custom cable that connects CD to Data Terminal Ready (DTR) on the controller side.*

1. Use the following diagram to attach the modem to the controller using the serial connector. As shown here, you can use either a DB9 or a DB25 connection.



NOTE: Pins 3 and 6 are tied together within the SNAP PAC R-series controller, so no external jumper is required.

2. Store configuration settings to the modem's NVRAM, following instructions in the user's guide for your modem.

   *NOTE: Configuration settings **must** be stored to the modem's NVRAM so they will be loaded when the SNAP PAC R-series controller sends a reset command to the modem.*

3. If PCs will dial up the controller, set up Windows dial-up networking on the PCs that will call the controller.

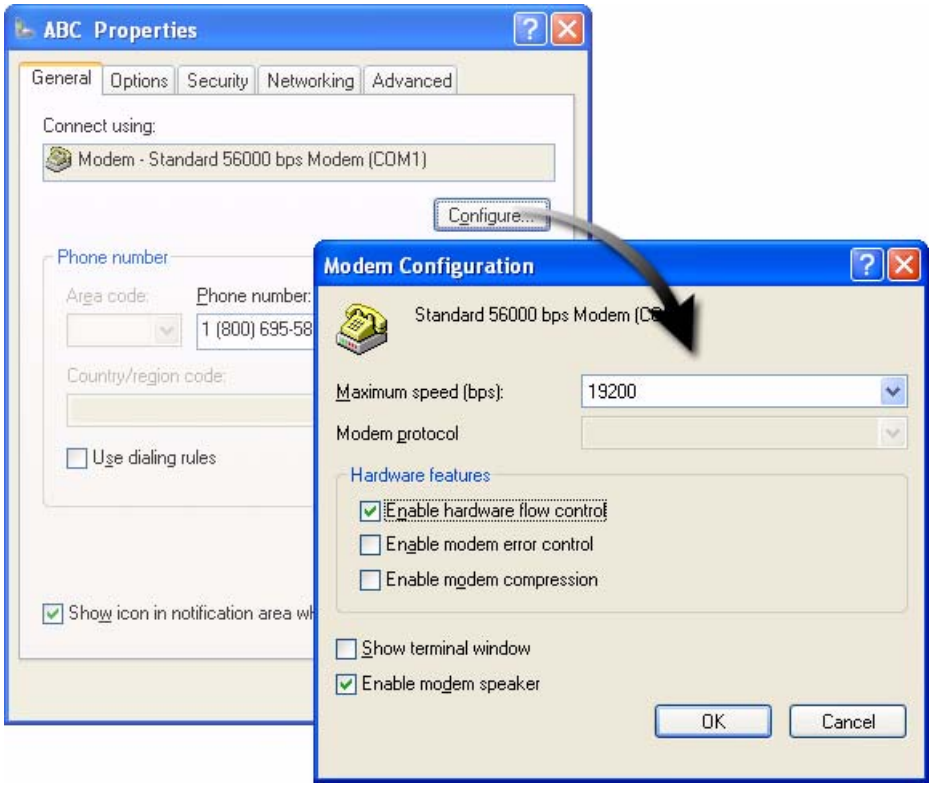
Configuring Microsoft Windows Dial-up Networking on Windows XP

Use the following settings to configure Windows dial-up networking on any PC that will dial in to the controller.

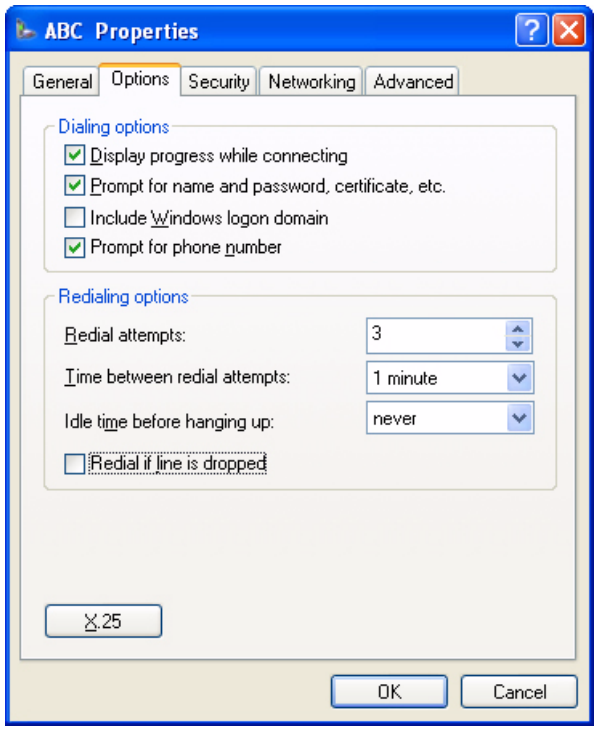
1. Click Start→Control Panel.
2. Double-click Network Connections.
3. Under Network Tasks, click Create a new connection to display the New Connection Wizard.
4. Follow the directions in the wizard to create a new dial-up connection.

5. When the new connection is created, right-click its name in the Network Connections window and select Properties.
6. In the Properties dialog box, set each tab as shown in the following figures:

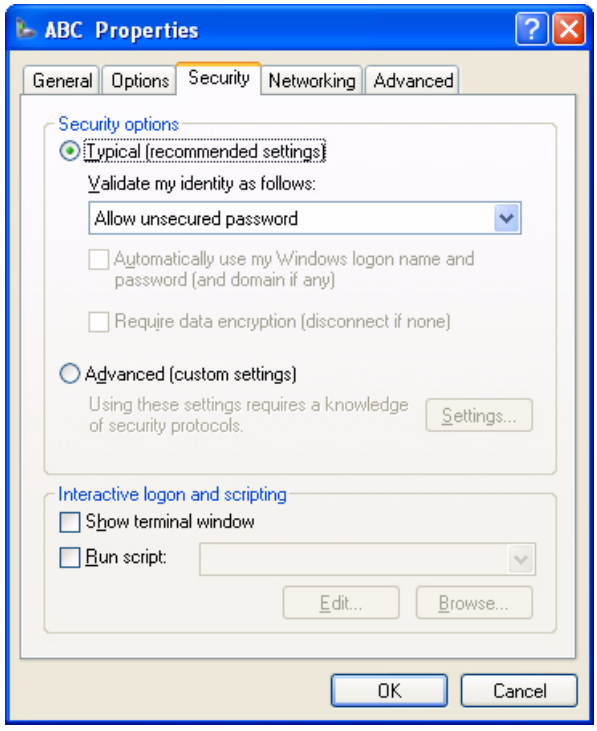
General Tab



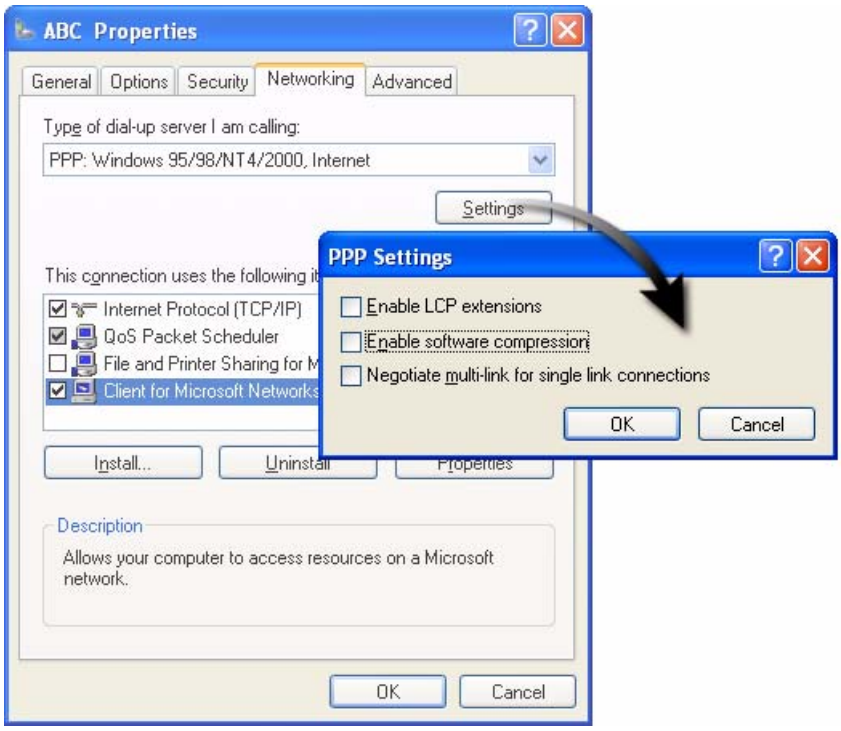
Options Tab



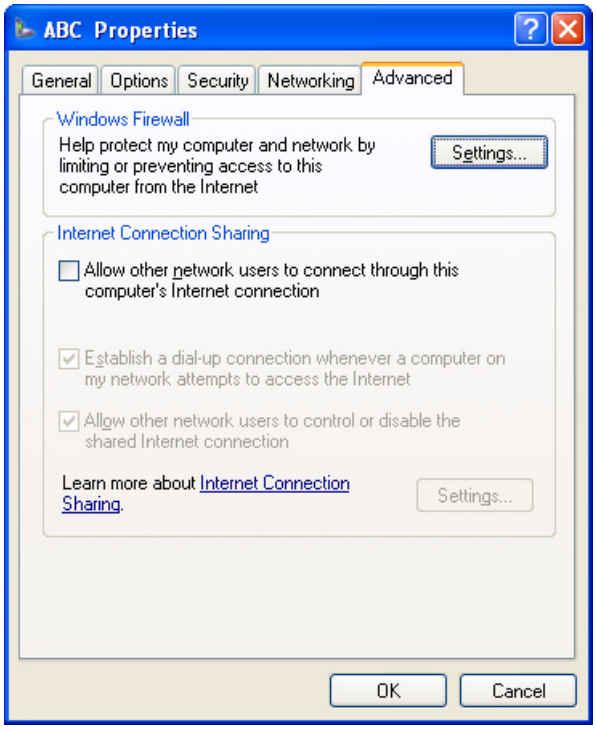
Security Tab



Networking Tab



Advanced Tab


ABC Properties
General
Options
Security
Networking
Advanced
Windows Firewall
Help protect my computer and network by limiting or preventing access to this computer from the Internet
Settings...
Internet Connection Sharing
Allow other network users to connect through this computer's Internet connection
Establish a dial-up connection whenever a computer on my network attempts to access the Internet
Allow other network users to control or disable the shared Internet connection
Learn more about Internet Connection Sharing.
Settings...
OK
Cancel

System Information

This chapter explains how to use SNAP PAC R-series controllers in an Ethernet network and how to communicate with them. It also provides information on system architecture, specifications, and features.

In This Chapter

Communication Options 17
System Architecture 20
Networking 26
Specifications, Connectors, and Dimensions 32
Information on Features 35
SNAP PAC R1 and R2 Comparison Chart 37

Communication Options

SNAP PAC R-series controllers communicate using TCP/IP or UDP/IP over a wired or wireless network.

Physical Layer—All SNAP PAC R-series controllers communicate over a 10- or 100-Mbps wired Ethernet link. SNAP PAC R-series controllers can also communicate using a modem over PPP.

Transport Layer—The key to SNAP PAC R-series controller communication flexibility is the transport layer, Internet Protocol (IP). Both the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP) are used with IP.

Application Layer—Because SNAP PAC R-series controllers use standard IP for the transport layer, many communication options are possible in the application layer. After the controller is installed and has an IP address assigned (see page 10), you can communicate with it using the following methods:

- **PAC Manager** software utility is used for assigning IP addresses, configuring I/O points and features, and performing onetime reads and writes.
- **PAC Control** strategies running on a SNAP PAC R-series I/O system industrial controller can configure, read, and write to I/O points controlled by controllers.

- **Custom software applications** are easy to develop using our OptoMMP Communication Toolkit with ActiveX components and C++ classes. They use an IEEE 1394-based protocol to read and write to SNAP PAC R-series controllers. For developers not using Microsoft Windows, our IEEE 1394-based protocol is open and documented.
- **Modbus/TCP** provides a direct connection with Modbus/TCP hardware or software or third-party software applications, which can read or write to I/O points on SNAP PAC R-series controllers.
- **OPC** (OLE for Process Control) uses OptoOPCServer to serve controller data to any OPC 2.0-compliant application, such as an HMI, which can also read or write to I/O points. OptoOPCServer can be purchased separately or as part of the PAC Project Professional software suite.
- **SMTP** (Simple Mail Transfer Protocol) connects a SNAP PAC R-series controller with corporate email servers, so employees can be emailed or paged if there's a problem on devices attached to the controller.
- **SNMP** (Simple Network Management Protocol) makes it possible to monitor devices attached to SNAP PAC R-series controllers just as you would any computer or server on the Ethernet network, using an SNMP-based enterprise management system such as Computer Associates' Unicenter®, Hewlett-Packard's OpenView®, or IBM's Tivoli®. When a monitored event occurs, such as a door left open or a pressure level too high, the controller sends an SNMP trap to the management system.
- **FTP** (File Transfer Protocol) can be used to transfer files and data to and from the SNAP PAC R-series controller, whether to custom applications, enterprise databases, or any file system.

Simultaneous Communication

In addition to communicating using all the methods listed above, each SNAP PAC R-series controller can also communicate *simultaneously* using all applicable methods.

The reason lies in the nature of IP. In serial communication, a single data request is sent by one device to another. The first device must wait for a response before any additional communication can be carried out. IP, however, can establish multiple simultaneous sessions, so many data requests can be sent at once without waiting for any individual response. Each request gets a response, but the link isn't idle while waiting for responses.

In addition, IP can simultaneously handle multiple requests from multiple devices. A PC can communicate with all SNAP PAC R-series controllers on the same network—all at the same time—and multiple PCs can communicate with one controller at the same time.

So, for example, a SNAP PAC R-series controller can respond to directions from a Modbus master, give analog point data to a technician using PAC Manager, and carry out instructions from a custom C++ application—all at once.

Accessing SNAP R-Series Controllers over the Internet

Since SNAP PAC R-series controllers are just like any other hardware on the Ethernet network, you can access them over the Internet in exactly the same way you would access a computer. The details depend on your network and Internet connection. Consult your system or network administrator or your Internet Service Provider (ISP) for more information.

Choosing Communication Methods

How do you need to communicate with SNAP PAC R-series controllers to match the tasks your application requires? Check the following table for help in choosing communication methods and finding out where to look for more information on them.

This task	Can be done using these methods		Details and references for information
	Recommended	Alternate	
Configure controllers.	PAC Manager (I/O points and other functions) or PAC Control (I/O points only)	OptoMMP Communication Toolkit or IEEE 1394-based protocol	If you are using PAC Control, configure the system in PAC Control configure mode. See the *PAC Control User's Guide*. For the Communication Toolkit or IEEE 1394-based protocol, see *OptoMMP Protocol Guide*.
Monitor and control processes.	PAC Control flowchart logic	PAC Manager Inspect window or OptoMMP Communication Toolkit or IEEE 1394-based protocol	See *PAC Control User's Guide* & *Command Reference*. CAUTION! Events and reactions set up using alternate methods are faster than flowchart logic, but be careful if you use them. They can conflict with PAC Control logic, because both write to the controller's memory map. For Communication Toolkit or IEEE 1394-based protocol, see *OptoMMP Protocol Guide*.
Send email to or page someone. Send SNMP trap. Monitor devices through an enterprise management system.	PAC Manager (for configuration), PAC Control	OptoMMP Communication Toolkit or IEEE 1394-based protocol	If you are using PAC Control, configure email using PAC Manager. See the *PAC Manager User's Guide*. For Communication Toolkit or IEEE 1394-based protocol, see *OptoMMP Protocol Guide*.
Give technicians an Opto 22 HMI with alarming and trending.	PAC Display		See *PAC Display User's Guide.*
Monitor and control SNAP PAC R-series controllers on the network.	PAC Control		PAC Control with a SNAP PAC R-series or SNAP PAC S-series controller (see *PAC Control User's Guide* & *Command Reference*)
Share strategy variable data with Opto 22 controllers and other SNAP PAC R-series controllers (peer-to-peer communication).	PAC Control (writes to memory map Scratch Pad areas)	Memory map Scratch Pad areas	PAC Control does not write directly to peers, but places data in the memory map so peers can retrieve it by reading memory map addresses. See *PAC Control User's Guide* & *Command Reference*. Also see controller's memory map in *OptoMMP Protocol Guide*.
Communicate with Modbus/TCP hardware or software.	Modbus/TCP		See the *Modbus/TCP Protocol Guide, form #1678*.
Exchange I/O point data with third-party software such as HMIs.	OptoOPCServer and controller's memory map		Purchase OptoOPCServer separately. See *OptoOPCServer User's Guide* and the memory map in *OptoMMP Protocol Guide*.
Exchange PAC Control strategy variable data with third-party software such as HMIs.	FTP and controller's file system	OptoOPCServer	Purchase OptoOPCServer separately. See *PAC Control User's Guide* and *OptoOPCServer User's Guide.*

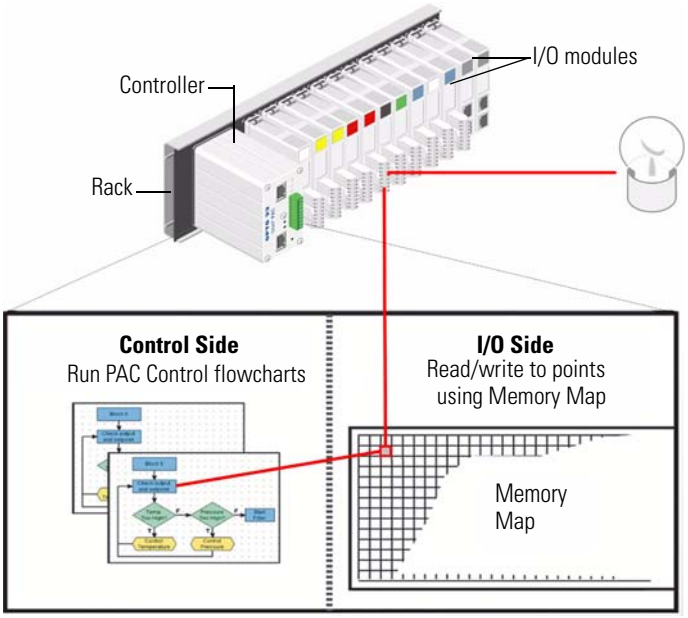
This task	Can be done using these methods		Details and references for information
	Recommended	Alternate	
Write your own software application to communicate with the system.	C++ or Active X: OptoMMP Communication Toolkit and controller's memory map.	Opto 22's IEEE 1394-based protocol and controller's memory map.	See *OptoMMP Protocol Guide.*

System Architecture

Because SNAP PAC R-series controllers are a combination of controller and I/O processor, their architecture is more complex than that of devices such as the SNAP EB-series brains, which are I/O processors only. The next few pages show the capabilities of this versatile system, starting with the simplest and moving to the more complex. Your application may require only some of these capabilities, but as your needs expand, remember that SNAP PAC R-series I/O can be used in all the ways shown, *simultaneously*.

Understanding the SNAP PAC R-series Controller

The SNAP PAC R-series controller merges two functions that are usually located in separate pieces of hardware: input/output processing and flowchart-based control. These two functions are handled by two "sides" of the controller, as illustrated below.



The rack is shown with the SNAP PAC R-series controller on the left and the input/output modules on the right.

The modules on the rack connect with devices in the real world, such as the light bulb, to monitor or control them.

The I/O Side of the Controller

The controller reads and writes to the I/O points using its I/O side memory map. This side of the SNAP PAC R-series controller is like SNAP EB-series brains.

You can think of the controller's memory map as a grid of mailboxes, with each mailbox having its own memory address. Each mailbox address has a specific purpose. For example, one address holds the state of a single digital point; another address holds counter data for the same point. There's an address that stores the controller's firmware version, one that contains the minimum value of a specific analog point, and many more. If you are familiar with programmable logic controllers (PLCs), you'll see that the memory map is similar to a register.

Most SNAP PAC R-series controllers run PAC Control flowcharts that automatically manipulate the memory map, so you probably won't need to understand it in detail. If you do need to refer to it, however, the complete list of memory map addresses is in Opto 22 form 1465, the *OptoMMP Protocol Guide*.

The Control Side of the Controller

The control side of the controller is like a traditional Opto 22 industrial controller. In the control side, the controller runs PAC Control flowcharts. These flowcharts provide the logic that controls processes through the system. Commands within the flowchart read from and write to the memory map in the I/O side of the controller in order to monitor and control the I/O points.

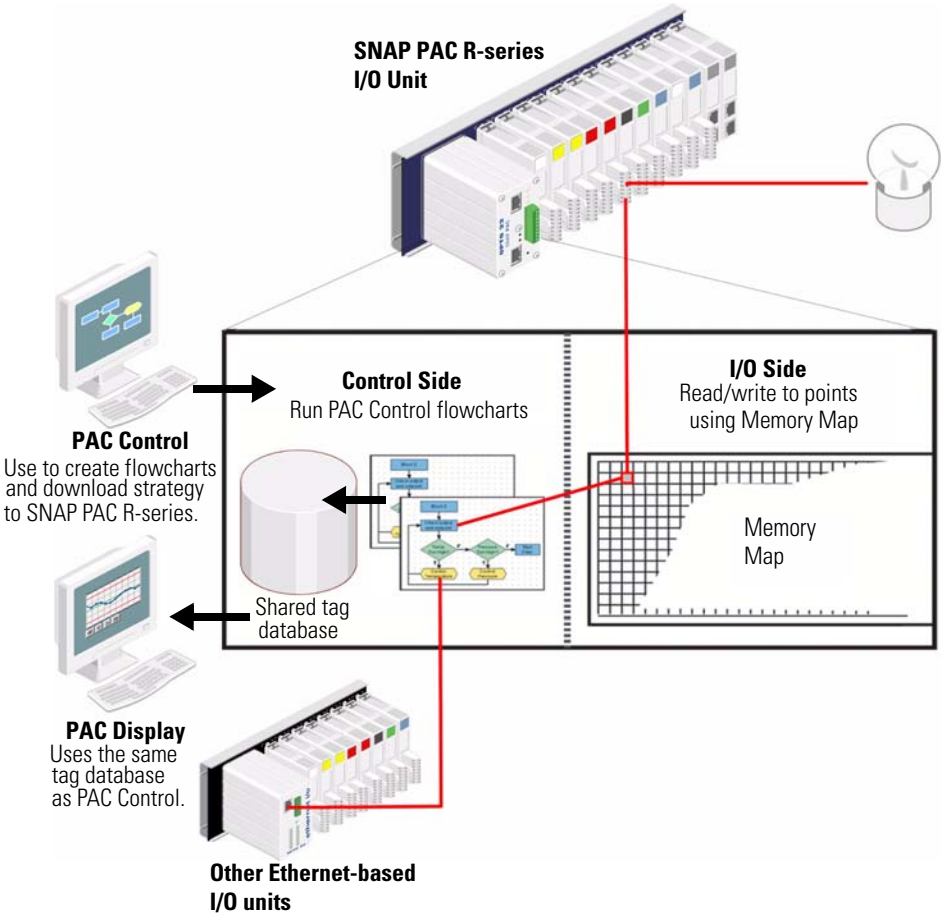
Controlling the System

The flowcharts that run in the control side of the controller are created in PAC Control, a software application included with the SNAP PAC R-series controller. You create these flowcharts as part of a *control strategy* and download the strategy to the controller, and the controller runs it independently. (For information on using PAC Control, see form #1700, the *PAC Control User's Guide*, and form #1701, the *PAC Control Command Reference*.)

You use PAC Control on a PC connected to the network, so you can create your control strategy and download it to the controller. Also included with the SNAP PAC R-series controller is PAC Display, a full-featured human-machine interface (HMI). PAC Display uses the same tag database as PAC Control, so points and variables are already defined. Operators, technicians, and engineers running PAC Display on a Microsoft Windows-based PC on the Ethernet network can see the information they need, as well as plot trends and respond to alarms.

For applications that require more than one I/O unit, the SNAP PAC R-series controller can control multiple I/O units through the flowcharts on its control side. These I/O units can be located where needed on the Ethernet network for distributed control.

The following diagram shows the control side of the controller:

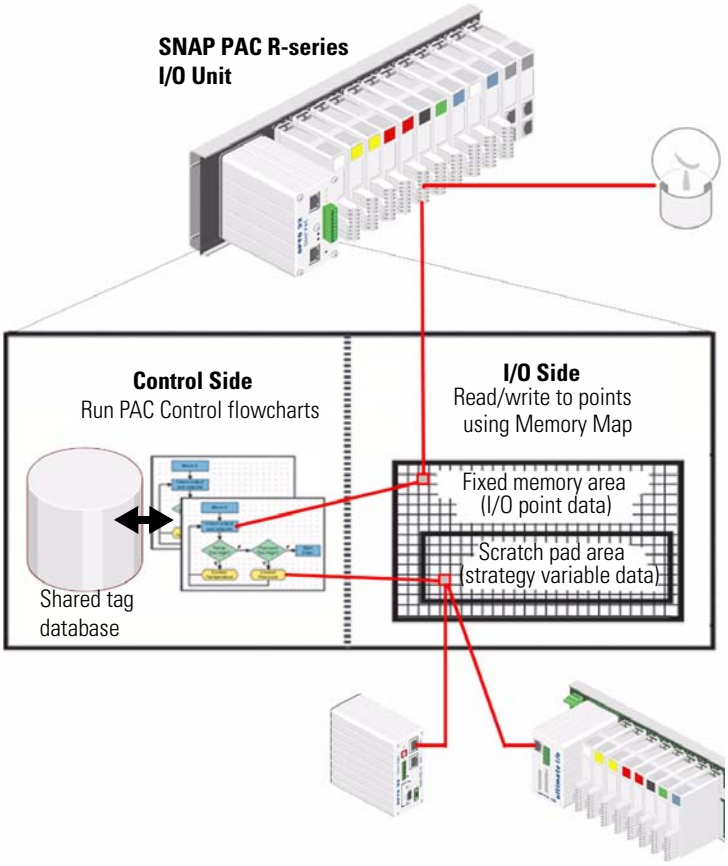


Using Data for Peer-to-Peer Communication

What if you have multiple SNAP PAC controllers? What if each one is running a different PAC Control strategy, and they need to share variable data?

Scratch Pad areas within the SNAP PAC R-series controller's memory map provide a way for other devices on the Ethernet network to access data in the controller. For descriptions of the Scratch Pad areas—bits, integers, floats, and strings—see the *PAC Manager User's Guide*. For help in using PAC Control commands to access Scratch Pad areas, see "I/O Unit—Scratch Pad Commands" in Chapter 10 of the *PAC Control User's Guide*.

The following illustration shows how this type of peer-to-peer communication can be done.



The memory map in the controller's I/O side has two parts: the fixed area and the Scratch Pad area.

The fixed memory area is used automatically by the controller to read and write data to I/O points; each address has a fixed purpose.

The Scratch Pad area, however, is user-defined; it is available for you to define and use as needed in order to exchange data among peers.

The Scratch Pad area includes four sections to accommodate different types of data: bits, integers, floats, and strings. The bit section is a 64-bit mask. Integer and float sections are tables of 10,240 four-byte elements. Strings are a table of 64 elements, each capable of holding 128 characters or 128 bytes of binary data.

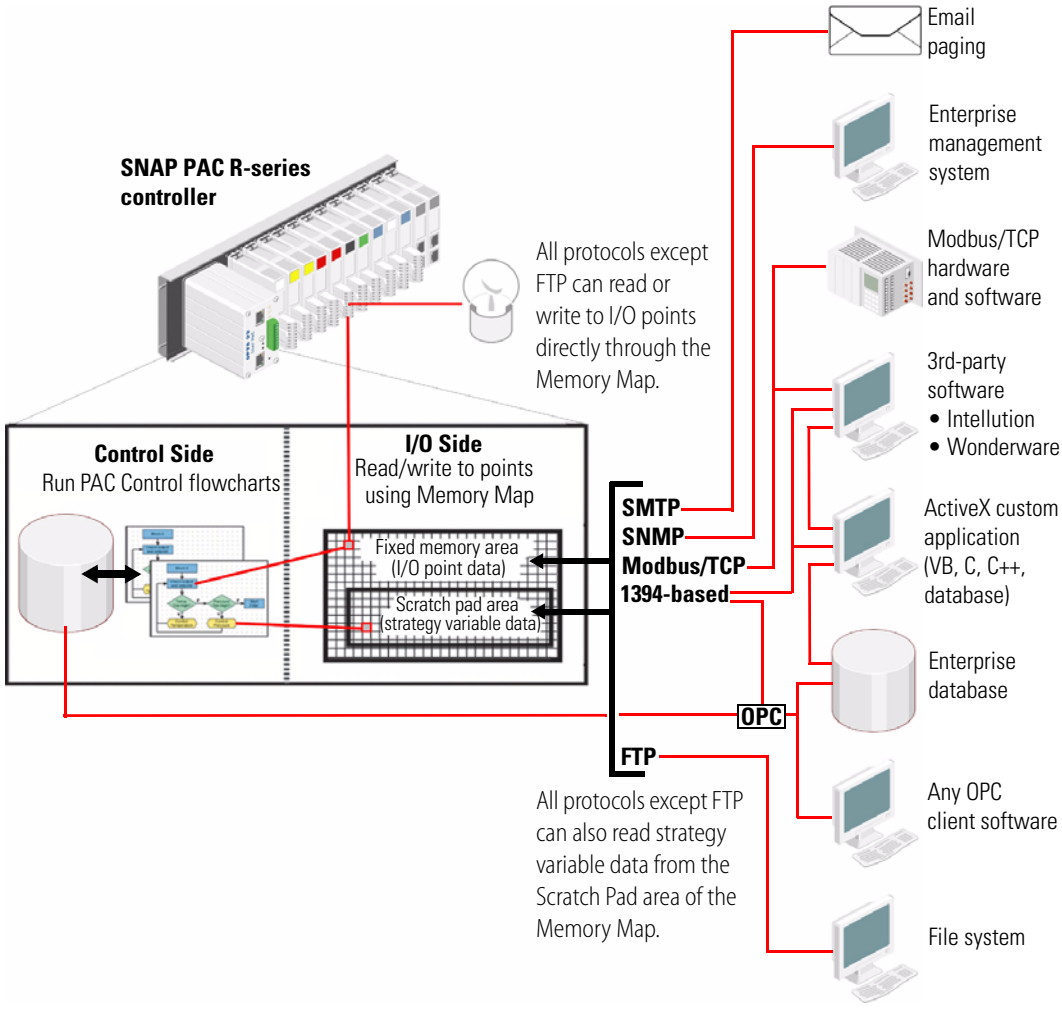
Using PAC Control commands in its flowcharts, the first SNAP PAC R-series controller can write strategy variable data to its Scratch Pad area. Other SNAP PAC controllers can use similar commands in their own flowcharts to read the data from the Scratch Pad area of the first controller. Similarly, another unit or controller can write to the Scratch Pad area of the first controller, which can then read the data deposited in its own Scratch Pad area by the peer. The reading and writing of data by peers to the Scratch Pad area must be very carefully coordinated in order to avoid conflicts.

For more information on using PAC Control commands for peer-to-peer communication, see "Communication Commands" in Chapter 10 of the *PAC Control User's Guide* and individual commands in the *PAC Control Command Reference*.

If you are not using PAC Control but writing your own software applications to access the Scratch Pad areas, see the *OptoMMP Protocol Guide*. This guide is written for I/O units, but much of the same information on programming applies to SNAP PAC controllers. The Scratch Pad areas of the memory map are described in the programming guide's appendix..

Communicating with Enterprise Systems and Third-Party Software

In addition to its capabilities in I/O, control, and peer-to-peer communication, the SNAP PAC R-series I/O system can also interface directly with enterprise systems and third-party software that need to use its data. The following graphic shows how these software applications (and some hardware, too) can directly access the memory map in the controller's I/O side for both I/O point data and strategy variable data.

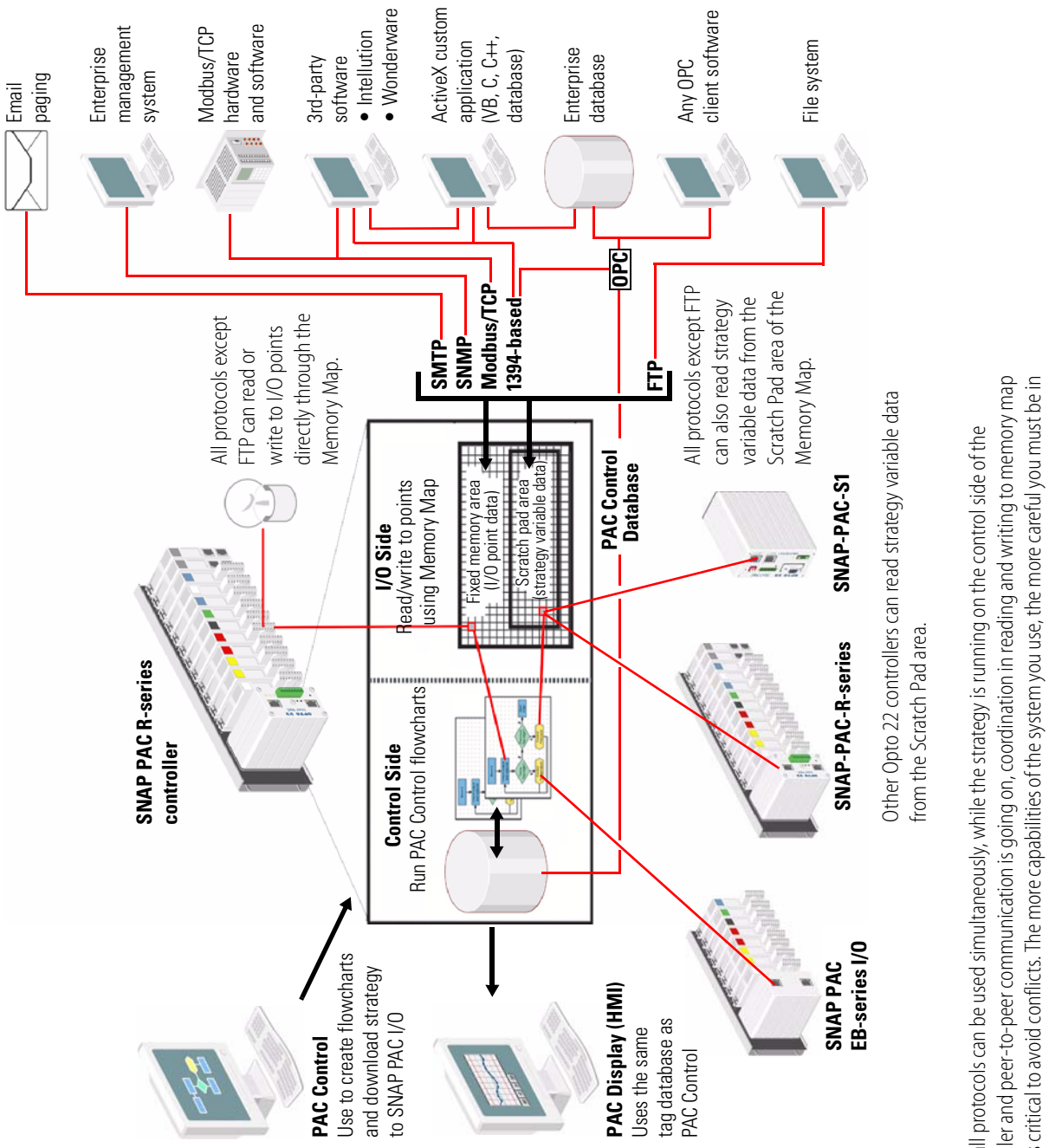


All of the protocols shown in the diagram, except FTP, can be used to communicate with both the fixed memory map area and the Scratch Pad area, so you can access both I/O point data in the fixed area and strategy variable data placed in the Scratch Pad area. In addition, strategy variable data from the PAC Control database can be directly used by OPC clients.

FTP can be used to access files on the SNAP PAC R-series controller, which are on the control side but can contain data from the I/O side (or any other data). For more information on the controller's file system and FTP, see the *PAC Control User's Guide* and the *PAC Manager User's Guide*.

The Complete System

When all these capabilities we've discussed are put together, you can see the versatility—and the wealth of applications—of the SNAP PAC R-series I/O system, shown below.


Email paging
Enterprise management system
Modbus/TCP hardware and software
3rd-party software
• Intellution
• Wonderware
ActiveX custom application (VB, C, C++, database)
Enterprise database
Any OPC client software
File system
OPC
SMTP
SNMP
Modbus/TCP
1394-based
FTP
All protocols except FTP can read or write to I/O points directly through the Memory Map.
All protocols except FTP can also read strategy variable data from the Scratch Pad area of the Memory Map.
I/O Side
Read/write to points using Memory Map
Fixed memory area (I/O point data)
Scratch pad area (strategy variable data)
PAC Control Database
Control Side
Run PAC Control flowcharts
SNAP PAC R-series controller
SNAP-PAC-S1
SNAP-PAC-R-series
SNAP PAC EB-series I/O
Other Opto 22 controllers can read strategy variable data from the Scratch Pad area.
PAC Control
Use to create flowcharts and download strategy to SNAP PAC I/O
PAC Display (HMI)
Uses the same tag database as PAC Control

Since all protocols can be used simultaneously, while the strategy is running on the control side of the controller and peer-to-peer communication is going on, coordination in reading and writing to memory map areas is critical to avoid conflicts. The more capabilities of the system you use, the more careful you must be in planning.

Networking

From a physical standpoint, SNAP PAC R-series controllers can be networked in several ways:

- Connected directly to a PC or controller using a crossover cable
- Attached to an existing TCP/IP Ethernet network
- As part of an independent network built with standard Ethernet hardware
- Over a modem connection

The networking method you use depends on several things, including whether you need control or data acquisition, the number of PCs, controllers, and I/O units you are using, the speed and volume of communication, security requirements, and the availability of an Ethernet network.

Connecting the Controller Directly to a PC or Master Controller

A direct connection using a crossover cable connects just one SNAP PAC R-series controller with one host. A direct connection is useful for assigning an IP address, configuring I/O points, and testing applications on I/O units that will be used later on a network.

A direct connection is quick, easy to do, and provides high speed and high security for a small system. The direct connection eliminates other variables that could interfere with communication, so you can focus on maintenance and troubleshooting.

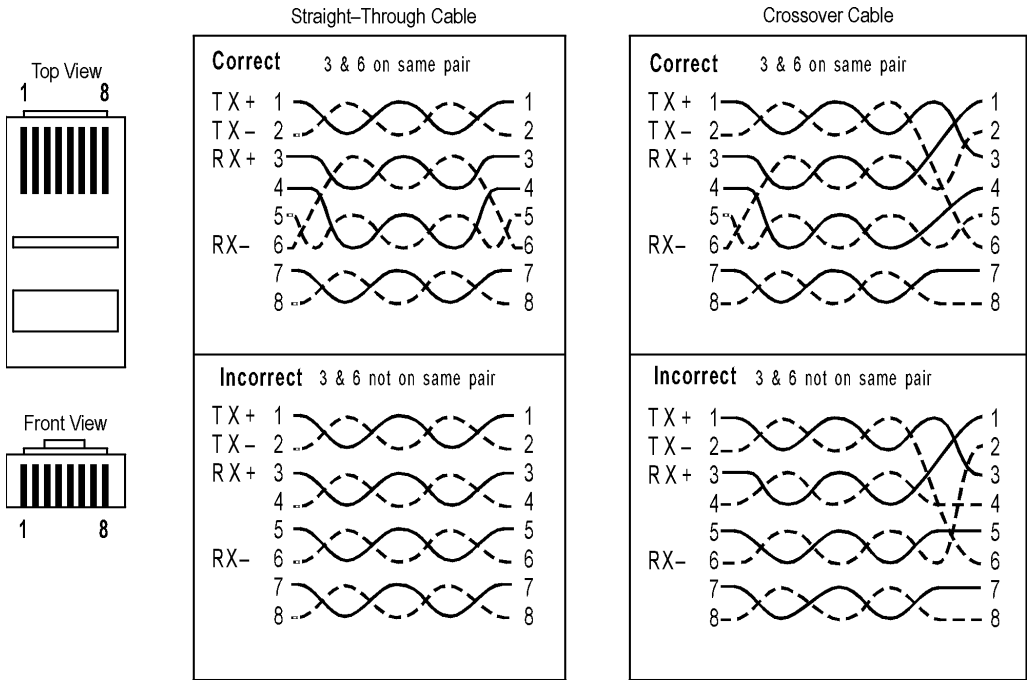
Crossover Cables

Use an Ethernet crossover cable for direct connections. The crossover cable must be a minimum of one meter long. (Maximum length is 100 meters.) For reliability, we recommend you purchase the cable, rather than build it.

If you build your own crossover cable, you'll need an RJ-45 male connector at each end. The cable includes four twisted pairs. Follow the illustration on the next page for wiring the connectors.

NOTE: The illustration shows on the next page both a straight-through *cable and a* crossover *cable. The straight-through cable is used for connecting the controller to a hub or switch on a standard Ethernet network. The crossover cable is used for direct connection to a PC or other host.*

If you're not sure which cable you have, hold up both ends so the connector tab is at the back of each end. Compare the color sequence of the wires in the connectors. If the sequence is identical for both connectors, it's a straight-through cable. If the sequence is different, it's a crossover cable.



NOTE: Make sure you put 3 and 6 on the same pair, or you may experience noise and distance limitations. Also, make sure to include all pairs, since they are required for 100 Mbps.

Attaching the Controller to an Existing Ethernet Network

The first rule in attaching SNAP PAC R-series controllers to an existing network is to work closely with your system administrator, who must determine network topology and hardware. Be sure to consider the impact on your existing network of adding the controllers.

In addition, make sure the system administrator understands that each controller must have a **fixed (static)** IP address, whether or not a Dynamic Host Configuration Protocol (DHCP) server is used on the network. For more information on IP addresses, see the *PAC Manager User's Guide*.

If you are using SNAP PAC R-series controllers for data acquisition, you can place the controller anywhere on an existing Ethernet network. If you are using the controller with control applications, however, the network segment design will depend on the number of hosts, the number of data transactions, and issues of data security. With fewer hosts and fewer data transactions, data packet collisions are less likely and system performance improves. If collisions are a problem, and especially if you need high throughput and predictable response times, it's best to put the controller on a separate switched network segment. We recommend switches, not hubs. For best performance, use a 100 Mbps network.

Segmenting the Control Network

If you need to segment the control system network from the main network backbone, you can use the two Ethernet interfaces on either the SNAP PAC R-series or an S-series controller. One interface can be connected to the enterprise network, and the other used for the control system. See the

diagram on page 30. (This implementation requires PAC Project Professional. For more information, see the *SNAP PAC R-series data sheet,* form #1594 and the *SNAP PAC S-series data sheet,* form #1584.) Or you might consider using a router, network switch, or other gateway device.

Using the Controller in an Independent Network

The third way SNAP PAC R-series controllers can be used is by developing an independent network. An independent network gives a high level of communication speed and volume, as well as high security. If you have no existing Ethernet network, you can use off-the-shelf Ethernet components to build one. Consider using industrial-grade Ethernet components for harsh and challenging environments.

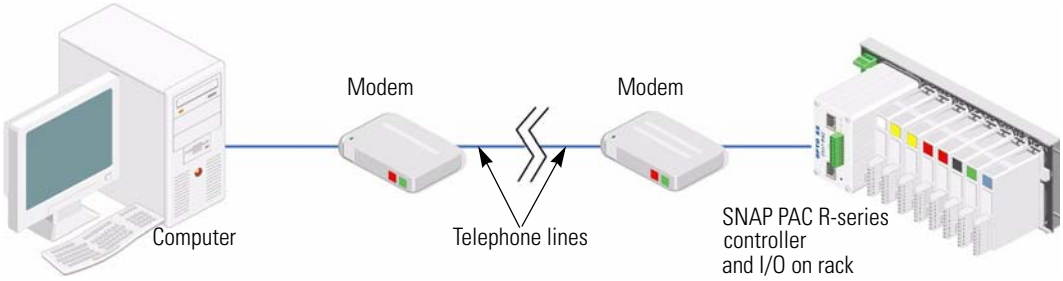
You may also need a separate network for critical control applications. Again, the choice depends on your requirements for data transactions, data security, and whether a near-deterministic system is necessary.

If you are building your own network, remember that each controller must have a **fixed** IP address. See the *PAC Manager User's Guide* for more information on IP addresses.

Since Ethernet and TCP/IP are worldwide standards, there are a number of commercially available resources for learning about building and maintaining such a network. One excellent resource is the *MCSE Training Guide: TCP/IP* by New Riders Publishing; many others are also available. We strongly suggest you learn as much as possible about the subject and plan your network carefully before beginning, in order to get the best performance from your system.

Communicating with the System via a Modem

A fourth way to use a SNAP PAC R-series controller is with a modem connection. This use is ideal for remote installations (for example, a communication tower or a pipeline) or in other places where a wired Ethernet network is not practical. Communication via modem uses the Point-to-Point Protocol (PPP) over an RS-232 link instead of an Ethernet link.



The system can dial out to a PC connected to a modem, or the PC can dial into the system, or both. If the system is also communicating via Ethernet, the network ID for the PPP interface on the controller must be different from the controller's Ethernet IP network ID.

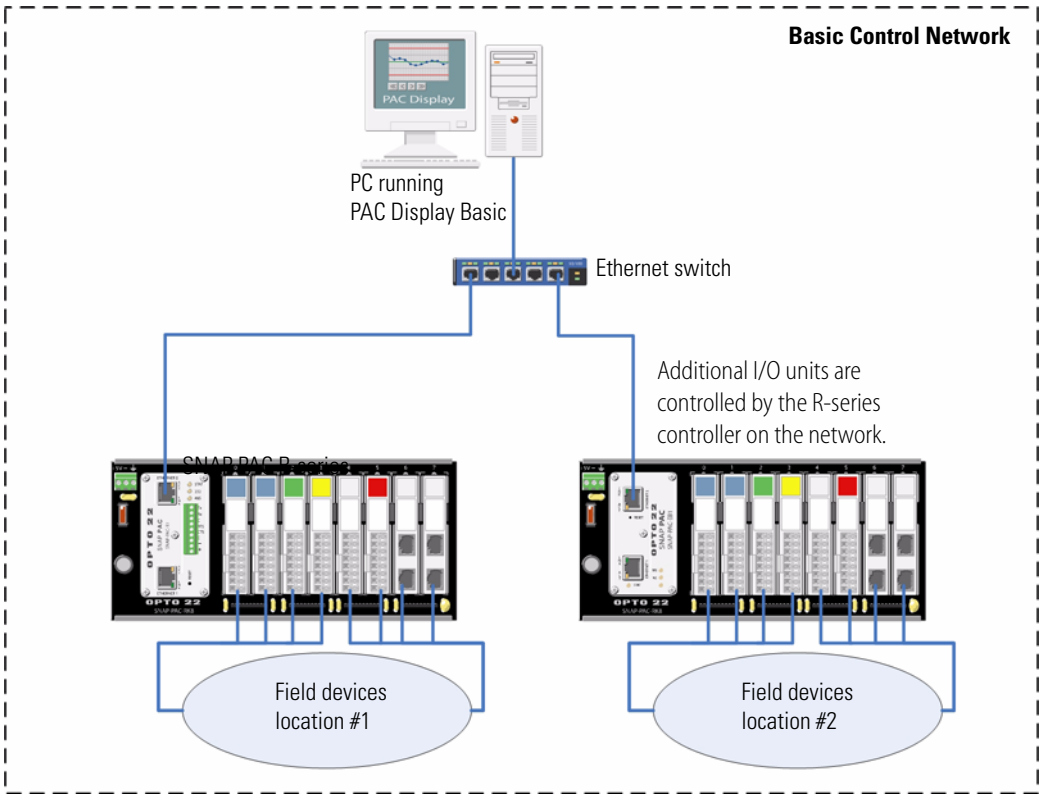
For more details on configuring the controller for use with a modem, see "Using PPP Over a Modem" on page 12.

Network Architecture Diagrams

Because SNAP PAC R-series controllers have two Ethernet interfaces and an RS-232 serial interface, these controllers are suitable for use in a variety of system layouts and architectures. For example, the dual independent Ethernet interfaces let you configure a network for link redundancy or segmented networking. As described in the previous section, the PPP serial interface provides a dial-up modem link for remotely located control systems. The serial interface can also be used to connect a serial device such as a barcode scanner.

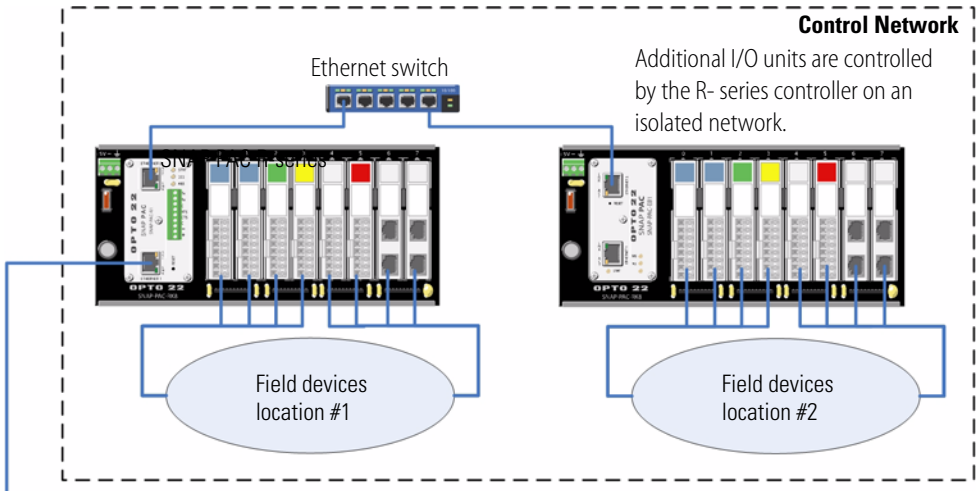
Basic Control Network

The following diagram shows a SNAP PAC R-series controller that uses one network interface to communicate with host computers and control I/O. The controller controls I/O on its own rack and on other SNAP PAC I/O units.

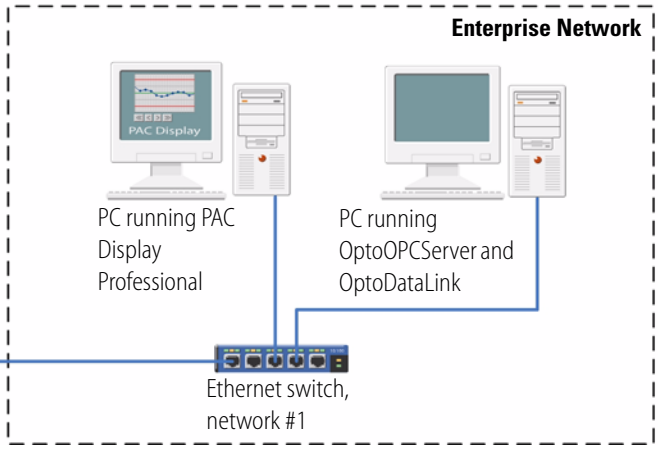


Network Segmenting: Ethernet Connections to Host and I/O Units

The following diagram shows two Opto 22 I/O units connected together over an Ethernet network and controlled by a SNAP PAC R-series controller running an PAC Control strategy. The network shown in this diagram requires PAC Control Professional and PAC Display Professional, and OptoDataLink.


Control Network
Ethernet switch
Additional I/O units are controlled by the R- series controller on an isolated network.
Field devices location #1
Field devices location #2

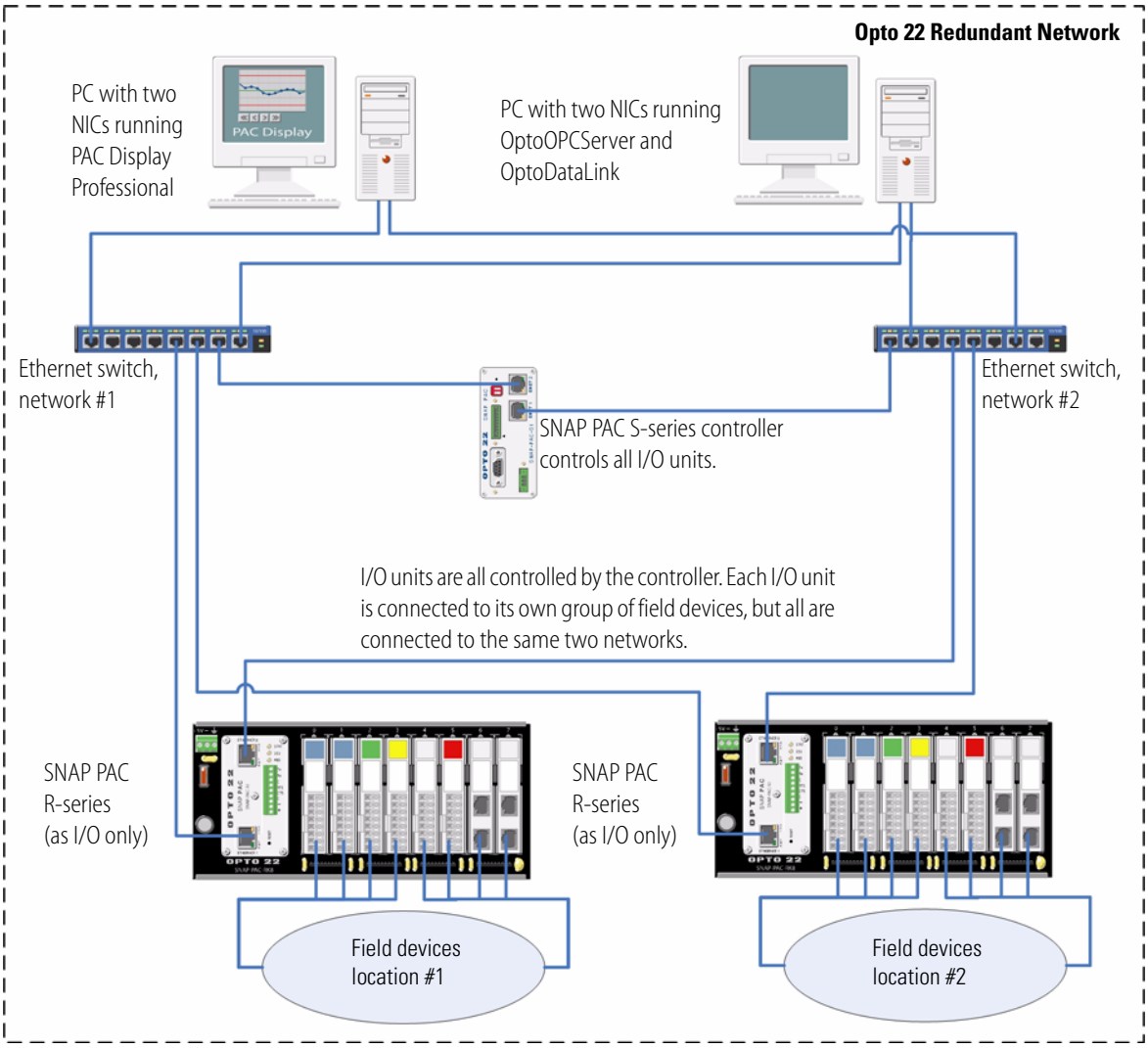
SNAP PAC R-series controller communicates with host computers through one network interface and controls I/O both directly on the rack and through the other Ethernet interface.



The controller is also connected to a larger, separate enterprise Ethernet network to provide data to PCs running Opto 22's PAC Display HMI software, OptoOPCServer, and OptoDataLink. Sitting between the two networks, the SNAP PAC R-series controller segments enterprise traffic from the control network.

Ethernet Link Redundancy

The following diagram shows two SNAP PAC R-series controllers functioning as I/O unit brains connected to two separate Ethernet networks. This configuration addresses the concern that an Ethernet network may fail or need maintenance, leaving the PC running OptoOPCServer, the PC running PAC Display, the controller, and the I/O units unable to communicate. The network shown in this diagram requires PAC Control Professional, PAC Display Professional, and OptoDataLink.


Opto 22 Redundant Network
PC with two NICs running PAC Display Professional
PAC Display
PC with two NICs running OptoOPCServer and OptoDataLink
Ethernet switch, network #1
Ethernet switch, network #2
SNAP PAC S-series controller controls all I/O units.
I/O units are all controlled by the controller. Each I/O unit is connected to its own group of field devices, but all are connected to the same two networks.
SNAP PAC R-series (as I/O only)
SNAP PAC R-series (as I/O only)
Field devices location #1
Field devices location #2

In this configuration, if one network goes down, devices can still communicate because the SNAP PAC S-series controller and the SNAP PAC R-series controllers both have two network interfaces, and each PC in this system has two network interface cards.

Specifications, Connectors, and Dimensions

Specifications

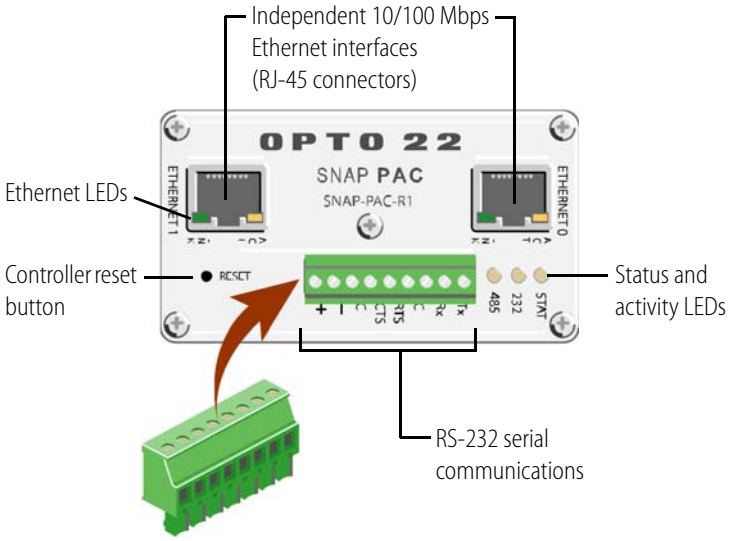
The following table shows specifications for the SNAP-PAC-R1 and R2 controller:

Processor	200 MHz 32-bit ColdFire® 5475 with integrated floating-point unit (FPU)
Memory Total RAM Battery-backed RAM Flash	 16 MB (4 MB available for PAC Control strategy; 2 MB available for file storage) 2 MB 8 MB (3.25 MB available for PAC Control strategy; 384 KB available for file storage)
Backup battery	3-volt rechargeable Data retention with power off: 3 years
Communication Ethernet (host and I/O) RS-232 serial (host only)	 Two independent 10/100 Mbps Ethernet network interfaces (RJ-45 connectors) Each interface has a separate IP address. *One RS-232 serial port with hardware handshaking
I/O unit compatibility	SNAP PAC I/O units: SNAP PAC R-series and EB-series I/O units
Power requirements	5.0–5.2 VDC @ 1.2 A
Environmental Operating temperature Storage temperature Humidity	 0 °C to 60 °C -40 °C to 85 °C 0% to 95% relative humidity, non-condensing
Software PAC Project Basic PAC Project Professional	 Includes programming, HMI software, and configuration software; included with purchase of controller. PAC Project Basic plus OPC 2.0-compliant OPC server, OptoControl strategy and OptoDisplay project importing, and Ethernet link redundancy or network segmenting support.
Other features	• Multiple protocol support including TCP/IP, FTP, Modbus/TCP, SNMP, OptoMMP™, and SMTP • Built-in I/O processor • Real-time clock • FTP server/client with file system • Scratch Pad area for peer-to-peer communication • Configurable link redundancy or segmented networking for I/O-controller subnetting (when using PAC Project Professional)

*The serial connector can be used for a modem connection using PPP. This connector can also be used for a direct connection to a serial device; communication is handled through PAC Control.

Connectors and LEDs

The following information applies to both SNAP-PAC-R1 and SNAP-PAC-R2 controllers.



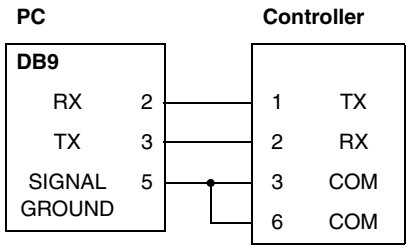
RS-232 Port

Pin	Description
1	TX
2	RX
3	COM
4	RTS
5	CTS
6	COM
7	DTR
8	DCD

Status and Activity LEDs

Indicator	Description
ACT	Ethernet network activity
LNK	Link established with Ethernet network
STAT	Startup status and control program operational status
232	RS-232 serial activity Color — Description Green — TX Red — RX Orange — TX/RX (transmitting and receiving simutaneously)
PPP	PPP status

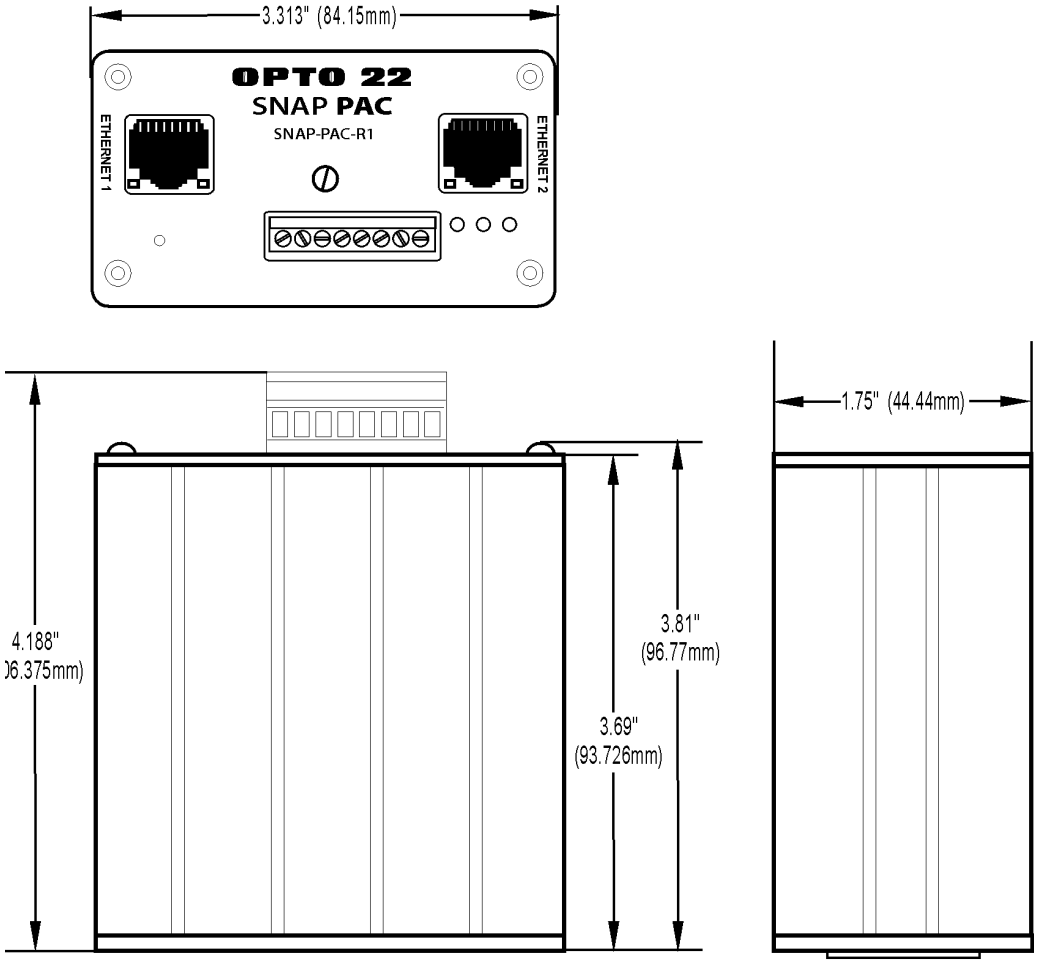
RS-232 Serial Cable Wiring*



* Minimum requirements for wiring an RS-232 serial cable to connect to a PC. If you want to connect the controller to a modem, see *page 13* for all eight pin connections.

Dimensions

The dimensions are the same for the SNAP-PAC-R1 and SNAP-PAC-R2 controllers.



Information on Features

SNAP PAC R-series controllers offer many features, described in the following sections.

Digital Point Features

For information on configuring digital point features, see the *PAC Manager User's Guide*.

Latches—When the value of a digital input point changes from off to on, an on-latch is automatically set. While the value of the point may return to off, the on-latch remains set until cleared, as a record of the change. Similarly, an off-latch is set when the value of a digital point changes from on to off, and it remains set until cleared. Latching is automatic and needs no configuration.

Watchdogs—You can set a watchdog to monitor communication with the PC or other host device. If the host does not write data to the controller for the length of time set in the watchdog, the controller automatically sets designated digital and analog I/O points (but not points on high-density digital modules) to the values you have determined. This action makes sure the process is brought to a safe state if communication fails.

High-speed counters—(R1 only) Any standard or high-density digital input can be used as a counter, counting the number of times the input changes from off to on. High-density digital points always act as counters without needing configuration. Standard digital points must be configured as counters; as soon as it is configured, the counter is automatically activated.

Quadrature counters—(R1 only) When you configure points on a quadrature input module, the quadrature counter feature is automatically included. You can read the quadrature count from either point by reading the point's counter data.

Additional digital features—(R1 only) The following digital features are available when a SNAP-PAC-R1 controller is used with PAC Control Professional. These features are not currently available through PAC Manager or the memory map. Use PAC Control commands to configure and access them. See the *PAC Control User's Guide* for more information.

- *On-pulse and off-pulse measurement*—A pulse is a brief on (or off) state, usually repeated at a specific interval. The controller can measure the first pulse, that is, the amount of time the input stays on (or stays off).
- *TPO (time-proportional output)*—Time-proportional output varies the duty cycle and the percentage of on time within that cycle. TPO is often combined with a PID loop and used to control the output, for example in a heater or oven.
- *Pulse generation*—Includes continuous square waves, on-pulses, off-pulses, and N pulses. A pulse turns a digital output on (or off) briefly, either once or for a specified number of times at a specified interval. A digital square wave is a specific pattern of on and off states, repeated continuously.

Analog Point Features

For information on configuring analog features, see the *PAC Manager User's Guide*.

Watchdogs—You can set a watchdog to monitor communication with the PC or other host device. If the host does not write data to the controller for the length of time set in the watchdog, the controller automatically sets designated I/O points to the values you have determined. This action makes sure the process is brought to a safe state if communication fails.

Scaling—You can scale analog input or output points so that the values make sense for your situation. For example, you can scale a -5 V to +5 V input point to show 0% to 100%.

Minimum and maximum values—The controller automatically keeps track of minimum and maximum values. You can read these values at any time, for example, to record minimum and maximum temperatures. You can also reset min/max values. For example, if you want to record the maximum temperature at point 2 in each 24-hour period, you must reset the values after they are read each day.

Offset and gain—The controller can calculate offset and gain for analog input points. If a -50 mV to +50 mV input receives signals that are slightly off (not exactly -50 mV at the lowest point, for example), the offset and gain can be calculated so that values will appear accurately when read.

NOTE: If you are using Modbus/TCP, you will need to calculate the offset and gain yourself. Then you can write offset and gain values to the controller.

Output clamping—The controller can clamp values sent to analog output points so they do not go above or below a specific limit. For example, if you are using a 0–10 VDC output module, but the device attached to one of its points can only handle a maximum of 5 VDC, you can set an upper clamp of 5 VDC for that point. The values for upper and lower clamp are set in engineering units.

Average filter weight—The controller can use a filter weight to smooth analog input signals that are erratic or change suddenly. See details in the *PAC Manager User's Guide*.

Ramping—(R1 only) Some devices attached to analog outputs should not be abruptly stepped up or down, because a sudden change might damage the equipment or cause other problems. Instead, you can gradually ramp the device up or down to the desired value.

IMPORTANT: Ramping is available only when used with PAC Control Professional. Ramping is not currently available through PAC Manager or the memory map. Use PAC Control commands to ramp an analog output. See the PAC Control User's Guide *for more information.*

Serial Communication

The SNAP PAC R-series controller can communicate with serial devices either through the RS-232 connector on top of the controller or though SNAP serial communication modules on the rack.

Communication through the RS-232 port is handled through PAC Control commands. See "Communication Commands" in Chapter 10 of the *PAC Control User's Guide*.

For additional serial connections, use SNAP serial communication modules. Most serial modules provide two channels of serial data, typically to interface with printers, scales, chart recorders, RFID

readers, or Wiegand® security devices. A Profibus module provides one channel of data from Profibus DP devices.

PID Loops

Proportional integral derivative (PID) loops are used to drive a variable, often from an analog input, toward a desired value. The PID monitors the variable, compares it to the setpoint (the desired value) and calculates an output that will push the variable very close to the setpoint. Temperature control is a typical application for a PID.

Each SNAP PAC R-series controller can run up to 96 PID loops. PID loops run on the I/O side, independently from an PAC Control strategy. To use PID loops, configure them in PAC Control or PAC Manager, and use PAC Control tuning tools for ease in debugging. See Opto 22 form #1700, the *PAC Control User's Guide*, for more information.

Additional Features

For information on configuring additional features available in the SNAP PAC R-series controller, including security and the use of protocols such as SNMP, SMTP, and FTP, see the *PAC Manager User's Guide*.

SNAP PAC R1 and R2 Comparison Chart

The following table compares SNAP-PAC-R1 and SNAP-PAC-R2 controllers.

FEATURE		SNAP-PAC-R1	SNAP-PAC-R2
Digital I/O point features	Input latching	●	●
	On/off status	●	●
	Watchdog timer	●	●
	High-speed counters (up to 20 kHz)[2]	●	
	Quadrature counters	●	
	On-pulse and off-pulse measurement[1,2]	●	
	TPO (time-proportional output)[1,2]	●	
	Pulse generation (N pulses, continuous square wave, on-pulse, and off-pulse)[1,2]	●	

FEATURE		SNAP-PAC-R1	SNAP-PAC-R2
Analog I/O point features	Thermocouple linearization (32-bit floating point for linearized values)	●	●
	Minimum/maximum values	●	●
	Offset and gain	●	●
	Scaling	●	●
	Time-proportional output	●	●
	Output clamping	●	●
	Filter weight	●	●
	Watchdog timer	●	●
	Ramping[1]	●	
High-density digital modules (inputs and outputs)		●	●
Serial communication modules		●	●
Serial events		●	●
PID logic on the brain		96 PIDs	96 PIDs
Digital events		●	●
Alarm events		●	●
Timers		●	●
Event messages		●	●
UDP Streaming		●	●
Email (SMTP client)		●	●
OPC driver		●	●
Data logging in the brain		●	●
Security (IP filtering, port access)		●	●
Realtime clock (RTC)		●	●
I/O point data mirroring		●	●
Memory map copying		●	●
Scratch Pad area—bits, floats, integers, strings		●	●
SNMP (network management of I/O & variables)		●	●
PPP (dial-up and radio modems)		●	●
FTP server and client		●	●
Modbus/TCP		●	●
OptoMMP memory-mapped protocol		●	●
Ethernet network		●	●
Serial (RS-232)		●	●

FEATURE	SNAP-PAC-R1	SNAP-PAC-R2
Runs PAC Project strategies	●	●
PAC Project compatibility (using SNAP PAC controller or brain)	●	●
Mounting rack	SNAP PAC racks	SNAP PAC racks
Number of modules per mounting rack	4, 8, 12, or 16	4, 8, 12, or 16
Module types and maximum numbers allowed per I/O unit (with largest rack)	16 digital[2] 16 analog 8 serial 16 HDD[3]	16 digital[2] 16 analog 8 serial 16 HDD[3]

1 Available when used with PAC Project Professional
2 4-channel digital modules
3 High-density digital modules

Maintenance and Troubleshooting

This chapter includes maintenance and troubleshooting information for SNAP PAC R-series controllers.

In This Chapter

Maintaining the SNAP PAC R-Series Controller:

Backup Battery....42
Changing the Controller's IP Address....42
Resetting the Controller....42
Loading New Firmware....43
Setting Time and Date....43
Blink Codes....43

Troubleshooting the SNAP PAC R-Series Controller:

Getting Device and Firmware Information....45
Communicating with the Controller....46
Additional Troubleshooting Tools....50
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SNAP Analog Troubleshooting....54

Maintaining the SNAP PAC R-Series Controller

Backup Battery

The SNAP PAC R-series controller has a rechargeable battery that receives charging current whenever the brain has power. It will retain data for up to three years with the power off.

Changing the Controller's IP Address

If you know the SNAP PAC R-series controller's IP address, see the *PAC Manager User's Guide* for instructions to change it.

If you do not know the IP address, first check the label on the side of the controller. There are two labels, one for each Ethernet port, so make sure to look at the right one. If you still don't know the controller's IP address, reset the controller to factory default settings following the instructions in "Resetting the Controller" on page 42 and then set the IP address as described in the *PAC Manager User's Guide*.

Resetting the Controller

1. Carefully insert a straightened paperclip or stiff wire into the small hole labeled RESET.
2. Press and hold down the RESET button as described below.

To perform this kind of reset...	...do this...	Result
Simple reset	Quickly press and release the RESET button. OR Cycle power to the controller. OR Use PAC Manager to send the controller the "Restart from Powerup" command.	The controller restarts. Any files, strategy, and archived strategy in RAM are erased. If these items have been stored to flash memory, they will not be erased.
Restore the factory default settings.	Press and hold the RESET button until the STAT LED turns solid green, and then immediately release the button.	The controller restarts. Any files, strategy, archived strategy, and persistent variables in RAM and flash memory are erased. IP addresses are reset to 0.0.0.0 and subnet masks to 255.255.255.0.

CAUTION: *If you hold down the RESET button longer than the time needed to restore the factory default settings, the controller will restart in Failsafe Bootloader mode. This is a diagnostic mode that you don't need to access unless you are troubleshooting a problem with Opto 22 Product Support. If your controller*

restarts in Failsafe Bootloader mode, simply cycle power to the device. This performs the simple reset described above and leaves the controller ready to load a new strategy.

Loading New Firmware

Each SNAP PAC R-series controller contains firmware (sometimes referred to as the *kernel*), which is similar to an operating system. If the firmware should become damaged, or if a new version of the firmware is released, you can load new firmware to the controller following instructions in the *PAC Manager User's Guide*.

Setting Time and Date

The SNAP PAC R-series controller's built-in clock is set at the factory. To change the time and date, see the instructions in the *PAC Manager User's Guide*.

Blink Codes

See also, "Connectors and LEDs" on page 33.

STAT LED

The STAT LED on the top of a SNAP PAC R-series controller uses blink codes to indicate status conditions. The blink codes can be useful during operation and in troubleshooting.

If the STAT LED is on and remains green, it indicates that a flowchart is running and a user task is being executed.

If the STAT LED is on and remains orange, it indicates that the controller is running, but no flowchart is running.

If the STAT LED blinks green when the controller starts up, it indicates the following:

Number of Blinks	Speed of Blinks	Means
2	fast	Loading firmware from Flash memory to SDRAM.
5	fast	Default settings have been successfully restored.
7	fast	Entering fail-safe bootloader mode. (See "Resetting the Controller" on page 42 for more information.)

If the STAT LED is blinking orange, it indicates the following:

Number of Blinks	Speed of Blinks	Means
(continuous)	slow	There is a problem with the bootloader. Contact Product Support.
(continuous)	fast	No IP address is assigned to the controller.

If the STAT LED is blinking red, it indicates the following:

Number of Blinks	Speed of Blinks	Means	Problem and Workaround
2	slow	Flash programming failure	Flash chips were not erased properly or programmed properly. Contact Product Support.
3	slow	Firmware CRC check failed.	Contact Product Support.
4	slow	Invalid MAC address or hardware revision	Contact Product Support.
5	slow	Fatal error	Firmware or hardware problem. Check the power supply and connections before restarting. Call Product Support if the error is repeated.
6	slow	RAM error	Contact Product Support.
7	slow	Loader problem	Firmware or hardware problem. Confirm Ethernet cables are connected. Try turning off power to the controller and turning it back on again. Call Product Support if the error is repeated.
11	slow	Firmware failed to initialize communications on ETHERNET 1.	Contact Product Support.
12	slow	Firmware failed to initialize communications on ETHERNET 2.	Contact Product Support.
13	slow	Real-time clock failure	Contact Product Support.

PPP LED

The programmable PPP LED must be set to PPP (the default) in order to indicate the current state of a PPP connection. For more information on programming the PPP LED, see the *OptoMMP Protocol Guide* form #1465 or the *PAC Manager User's Guide* form #1704.

The PPP LED blink codes are as follows:

Color of LED	Speed of Blinks	Means
Green	Solid	There is a PPP connection.
Green	Slow	A PPP connection is being established.
Orange	Solid	The controller is listening on its PPP port.
Orange	Slow	PPP is disconnecting . After disconnecting, if Incoming PPP is enabled in PAC Manager, PPP will listen for incoming calls. Otherwise, PPP will enter the Idle state (from which it can initiate an outgoing call). For more information on configuring PPP, see the *PAC Manager User's Guide*.
Red	Slow	The PPP service has been instructed to stop and is shutting down.
Off	n/a	The PPP connection is idle or disabled.

232 LED

The 232 LEDs indicate the following:

Color of LED	Means
Green	The controller is transmitting data.
Red	The controller is receving data.
Orange	The controller is transmitting and receiving data.

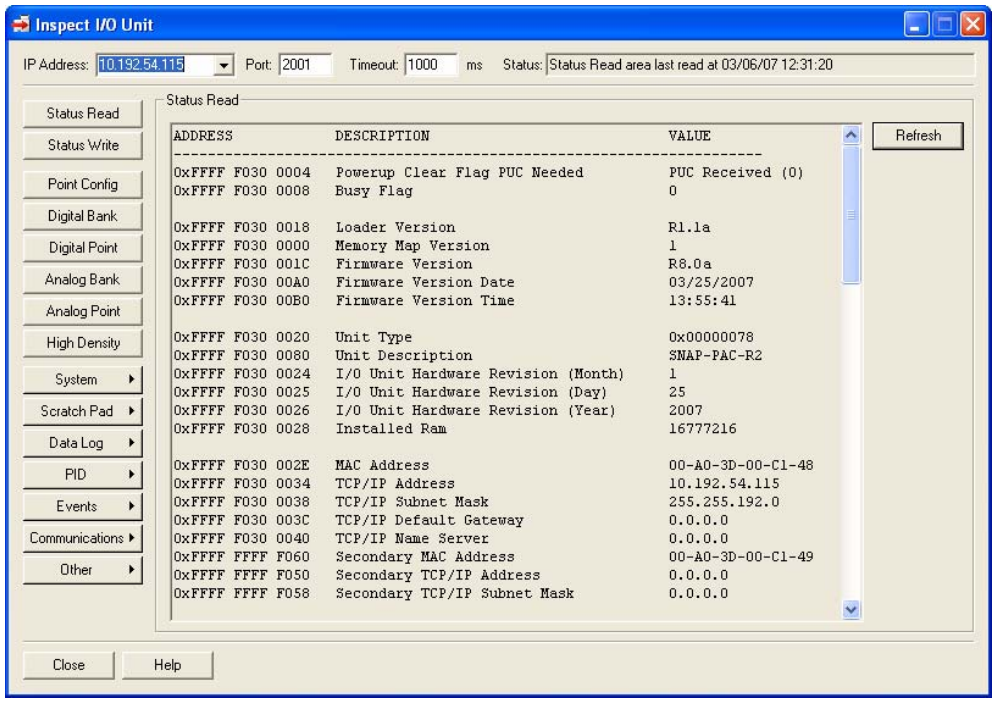
Troubleshooting the SNAP PAC R-Series Controller

If you encounter a problem while installing or using the SNAP PAC R-series controller, check the information in this section. If you need to contact Opto 22 Product Support, see "For Help" on page 5.

Getting Device and Firmware Information

If you need to contact Opto 22 Product Support for assistance in using an I/O unit or controller, it is helpful to have device and firmware information at hand before you call us.

1. Choose Start→Programs→Opto 22→PAC Project→PAC Manager.
2. In the PAC Manager main window, click the Inspect button .
3. In the IP Address field, type the IP address of the device. Click Status Read.


Inspect I/O Unit
IP Address: 10.192.54.115
Port: 2001
Timeout: 1000 ms
Status: Status Read area last read at 03/06/07 12:31:20
Status Read
Status Write
Point Config
Digital Bank
Digital Point
Analog Bank
Analog Point
High Density
System
Scratch Pad
Data Log
PID
Events
Communications
Other
Status Read
Refresh
ADDRESS DESCRIPTION VALUE
0xFFFF F030 0004 Powerup Clear Flag PUC Needed PUC Received (0)
0xFFFF F030 0008 Busy Flag 0
0xFFFF F030 0018 Loader Version R1.1a
0xFFFF F030 0000 Memory Map Version 1
0xFFFF F030 001C Firmware Version R8.0a
0xFFFF F030 00A0 Firmware Version Date 03/25/2007
0xFFFF F030 00B0 Firmware Version Time 13:55:41
0xFFFF F030 0020 Unit Type 0x00000078
0xFFFF F030 0080 Unit Description SNAP-PAC-R2
0xFFFF F030 0024 I/O Unit Hardware Revision (Month) 1
0xFFFF F030 0025 I/O Unit Hardware Revision (Day) 25
0xFFFF F030 0026 I/O Unit Hardware Revision (Year) 2007
0xFFFF F030 0028 Installed Ram 16777216
0xFFFF F030 002E MAC Address 00-A0-3D-00-C1-48
0xFFFF F030 0034 TCP/IP Address 10.192.54.115
0xFFFF F030 0038 TCP/IP Subnet Mask 255.255.192.0
0xFFFF F030 003C TCP/IP Default Gateway 0.0.0.0
0xFFFF F030 0040 TCP/IP Name Server 0.0.0.0
0xFFFF FFFF F060 Secondary MAC Address 00-A0-3D-00-C1-49
0xFFFF FFFF F050 Secondary TCP/IP Address 0.0.0.0
0xFFFF FFFF F058 Secondary TCP/IP Subnet Mask 0.0.0.0
Close
Help

Keep this window open on your screen when you call Product Support.

Communicating with the Controller

If you attempt to connect to the controller using its IP address and you cannot, first check the following:

- Make sure the controller has been turned on and the LNK and STAT LEDs for the connected Ethernet interfaces are lit (see "Connectors and LEDs" on page 33.)
- Make sure the controller is mounted on a SNAP PAC rack.
- Make sure the controller's hold-down screw has been tightened so that it is firmly attached to the rack.
- Verify that you typed in the correct address for the controller. Check the label on the side of the controller, where the IP address should be written. There are two labels, one for each Ethernet port, so make sure to look at the right one.
- Make sure the controller has been assigned a valid IP address and subnet mask. SNAP PAC R-series controllers come from the factory with a default IP address of 0.0.0.0, which is invalid. The default subnet mask is 255.255.255.0. To assign an IP address and subnet mask, see the *PAC Manager User's Guide*.
- Make sure that no red LEDs on the controller are lit. A red LED could indicate a voltage supply problem. Each controller should have its own power supply. The controller needs a minimum of 5.0 VDC, measured at the rack.
- Make sure you have up-to-date drivers installed on your computer's Network Interface Card (NIC). Contact your system administrator or the manufacturer of the card for help.

- Make sure you have Administrator privileges on your computer and that any firewall in the computer (such as the built-in firewall in Windows XP) is temporarily disabled before you try to assign or change IP addresses, load firmware using PAC Manager's Maintenance window, or work with files on the controller. BootP and FTP cannot function through a firewall in the PC. Firewalls in a router are less likely to be a problem unless certain ports (such as FTP client) have been blocked, either by default or on purpose.

Pinging the Controller

If you still cannot communicate with the controller after you have checked these items, try to reach it using the PING protocol.

1. Choose Start→Programs→Accessories and open a command prompt.
2. At the prompt, type: `ping [controller's IP address]`

   For example, type: `ping 10.192.54.40`

If the controller responds, go to "Accessing the Controller with PAC Manager" on page 47.

If the PING command cannot be found, choose Start→Control Panel→Network. Make sure TCP/IP is configured as a protocol and that an IP address and subnet mask are assigned.

If you see the message "Destination host route not defined," the controller probably has an inappropriate IP address and subnet mask. Make sure the IP address and subnet mask on the controller are compatible with those on the computer. Follow the directions beginning on page 42 to check the IP address and subnet mask on the controller, and change them if necessary.

If you see the message "No response from host," check the following:

- Are the computer and controller correctly connected? Is the controller turned on?
- Are the IP address and subnet mask on the controller compatible with those on the computer?
- Is the controller in reset mode? (Check for a blinking STAT LED. STAT blink codes are shown on page 43.)

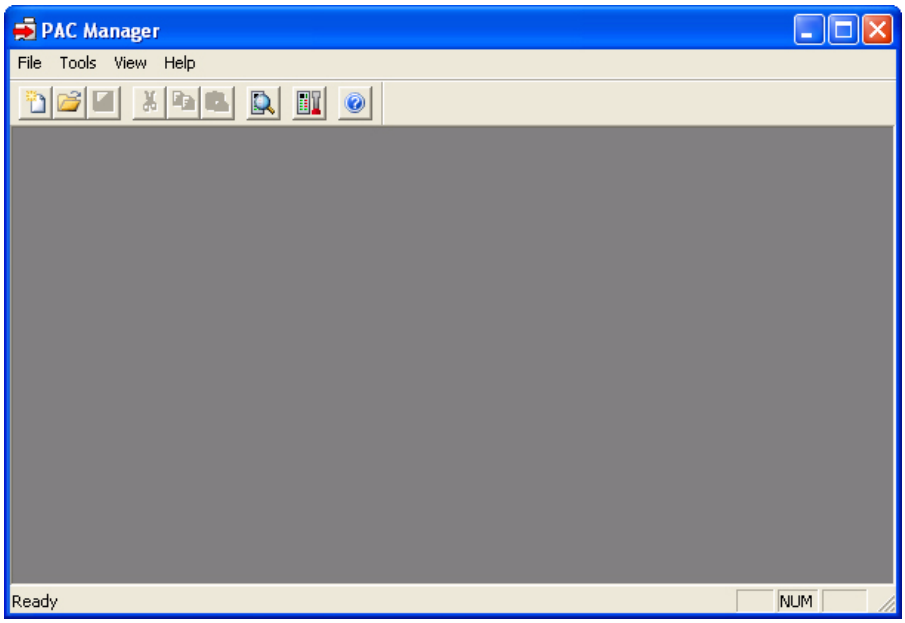
If you still cannot ping the controller, contact Opto 22 Product Support. (See page 5.)

Accessing the Controller with PAC Manager

Once you know you can ping the controller, try to access it using PAC Manager. You will need to know the controller's IP address.

1. If PAC Manager is not already open, choose Start→Programs→Opto 22→PAC Project→PAC Manager.

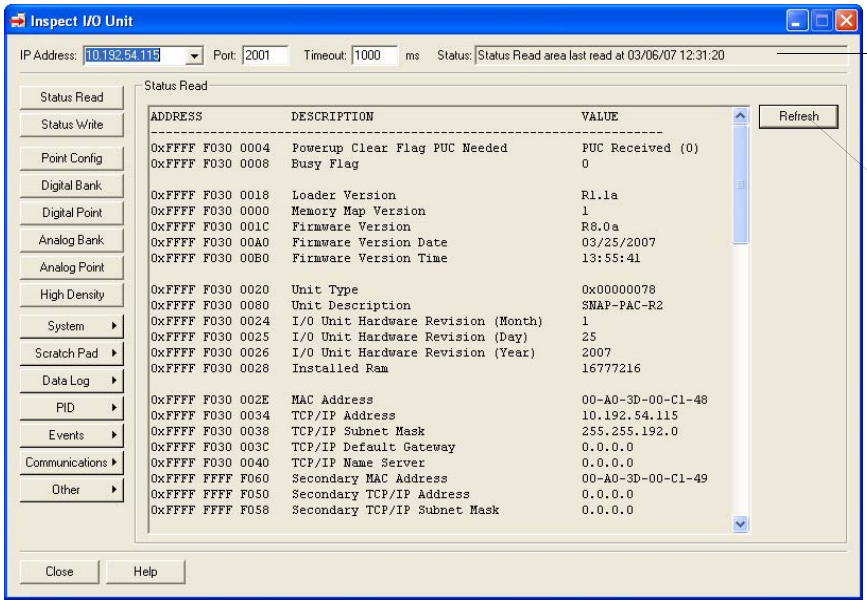
   The PAC Manager main window opens:



2. In the PAC Manager main window, click the Inspect button .

3. In the IP Address field, type the IP address of the controller (or choose it from the drop-down list). Click Status Read.

   Information from the controller is displayed in the window:


Inspect I/O Unit
IP Address: 10.192.54.115
Port: 2001
Timeout: 1000 ms
Status: Status Read area last read at 03/06/07 12:31:20
Status Read
Status Write
Point Config
Digital Bank
Digital Point
Analog Bank
Analog Point
High Density
System
Scratch Pad
Data Log
PID
Events
Communications
Other
Status Read
Refresh
ADDRESS DESCRIPTION VALUE
0xFFFF F030 0004 Powerup Clear Flag PUC Needed PUC Received (0)
0xFFFF F030 0008 Busy Flag 0
0xFFFF F030 0018 Loader Version R1.1a
0xFFFF F030 0000 Memory Map Version 1
0xFFFF F030 001C Firmware Version R8.0a
0xFFFF F030 00A0 Firmware Version Date 03/25/2007
0xFFFF F030 00B0 Firmware Version Time 13:55:41
0xFFFF F030 0020 Unit Type 0x00000078
0xFFFF F030 0080 Unit Description SNAP-PAC-R2
0xFFFF F030 0024 I/O Unit Hardware Revision (Month) 1
0xFFFF F030 0025 I/O Unit Hardware Revision (Day) 25
0xFFFF F030 0026 I/O Unit Hardware Revision (Year) 2007
0xFFFF F030 0028 Installed Ram 16777216
0xFFFF F030 002E MAC Address 00-A0-3D-00-C1-48
0xFFFF F030 0034 TCP/IP Address 10.192.54.115
0xFFFF F030 0038 TCP/IP Subnet Mask 255.255.192.0
0xFFFF F030 003C TCP/IP Default Gateway 0.0.0.0
0xFFFF F030 0040 TCP/IP Name Server 0.0.0.0
0xFFFF FFFF F060 Secondary MAC Address 00-A0-3D-00-C1-49
0xFFFF FFFF F050 Secondary TCP/IP Address 0.0.0.0
0xFFFF FFFF F058 Secondary TCP/IP Subnet Mask 0.0.0.0
Close
Help

Date and time data was last read

Click to update data

If information does not appear, contact Product Support. (See page 5.)

Solving Network Problems

If there are recurring problems in communicating with the controller, check your network. The wires, switches, and so on in your Ethernet network are not part of the Opto 22 hardware, but any problems in your network may affect communication with Opto 22 products.

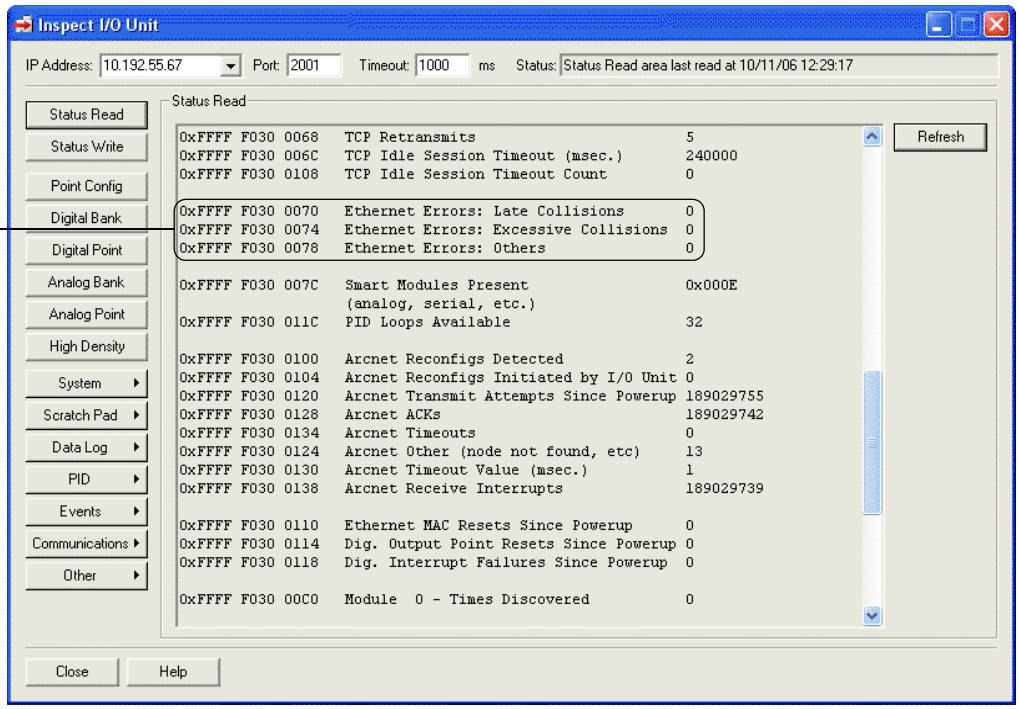
Create a Network Diagram. —First, create a network diagram and verify the following:

- Cable connectors are firmly inserted.
- The switch has power. Switch LEDs indicate that the connection is up.
- Neither the PC nor the controller uses the switch's uplink port.
- The SNAP PAC R-series controller's LNK LED is lit.

Check Ethernet Errors. —Next, use PAC Manager to check Ethernet errors reported by the controller. These errors indicate network problems. You will need to know the controller's IP address.

1. Choose Start→Programs→Opto 22→PAC Project→PAC Manager.
2. In the PAC Manager main window, click the Inspect icon .
3. In the IP Address field, type the IP address of the controller. Click Status Read.
4. Scroll down until you see the items Ethernet Errors: Late Collisions, Ethernet Errors: Excessive Collisions, and Ethernet Errors: Others.

Ethernet Errors


Inspect I/O Unit
IP Address: 10.192.55.67
Port: 2001
Timeout: 1000 ms
Status: Status Read area last read at 10/11/06 12:29:17
Status Read
Status Write
Point Config
Digital Bank
Digital Point
Analog Bank
Analog Point
High Density
System
Scratch Pad
Data Log
PID
Events
Communications
Other
Refresh
0xFFFF F030 0068 TCP Retransmits 5
0xFFFF F030 006C TCP Idle Session Timeout (msec.) 240000
0xFFFF F030 0108 TCP Idle Session Timeout Count 0
0xFFFF F030 0070 Ethernet Errors: Late Collisions 0
0xFFFF F030 0074 Ethernet Errors: Excessive Collisions 0
0xFFFF F030 0078 Ethernet Errors: Others 0
0xFFFF F030 007C Smart Modules Present (analog, serial, etc.) 0x000E
0xFFFF F030 011C PID Loops Available 32
0xFFFF F030 0100 Arcnet Reconfigs Detected 2
0xFFFF F030 0104 Arcnet Reconfigs Initiated by I/O Unit 0
0xFFFF F030 0120 Arcnet Transmit Attempts Since Powerup 189029755
0xFFFF F030 0128 Arcnet ACKs 189029742
0xFFFF F030 0134 Arcnet Timeouts 0
0xFFFF F030 0124 Arcnet Other (node not found, etc) 13
0xFFFF F030 0130 Arcnet Timeout Value (msec.) 1
0xFFFF F030 0138 Arcnet Receive Interrupts 189029739
0xFFFF F030 0110 Ethernet MAC Resets Since Powerup 0
0xFFFF F030 0114 Dig. Output Point Resets Since Powerup 0
0xFFFF F030 0118 Dig. Interrupt Failures Since Powerup 0
0xFFFF F030 00C0 Module 0 - Times Discovered 0
Close
Help

All three of these items should have a value of zero. If any of these items has a value other than zero, you may have a network problem.

Analyze Communication Packets. If it appears that you have network problems, you can use the OptoEnetSniff™ utility to log and analyze network communication packets. The utility is included with PAC Project Basic and PAC Project Professional software suites, and is available on our website, www.opto22.com. For help using the utility, see its online help file (choose Help→Contents).

Have Your Network Certified. If you suspect network problems, you may need to have your network professionally certified. Opto 22 does not offer network validation or certification services, but many network hardware manufacturers do. Contact the manufacturer of your Ethernet network hardware to have them diagnose, fix, and certify your network.

If you continue to have problems communicating with the SNAP PAC R-series controller after your network is certified, contact Opto 22 Product Support. (See page 5.)

Additional Troubleshooting Tools

Making Sure the Controller is in Normal Mode

If you are having trouble communicating with the controller, it might be in *fail-safe bootloader mode*. This is a diagnostic mode that you don't need to access unless you are troubleshooting a problem with Opto 22 Product Support. The controller restarts in fail-safe bootloader mode when you hold down the RESET button longer than the time needed to restore the default settings. If your controller restarts in fail-safe bootloader mode, simply cycle power to the device. This action performs a simple reset and allows you to communicate with the controller. For more information on using the RESET button, see "Resetting the Controller" on page 42.

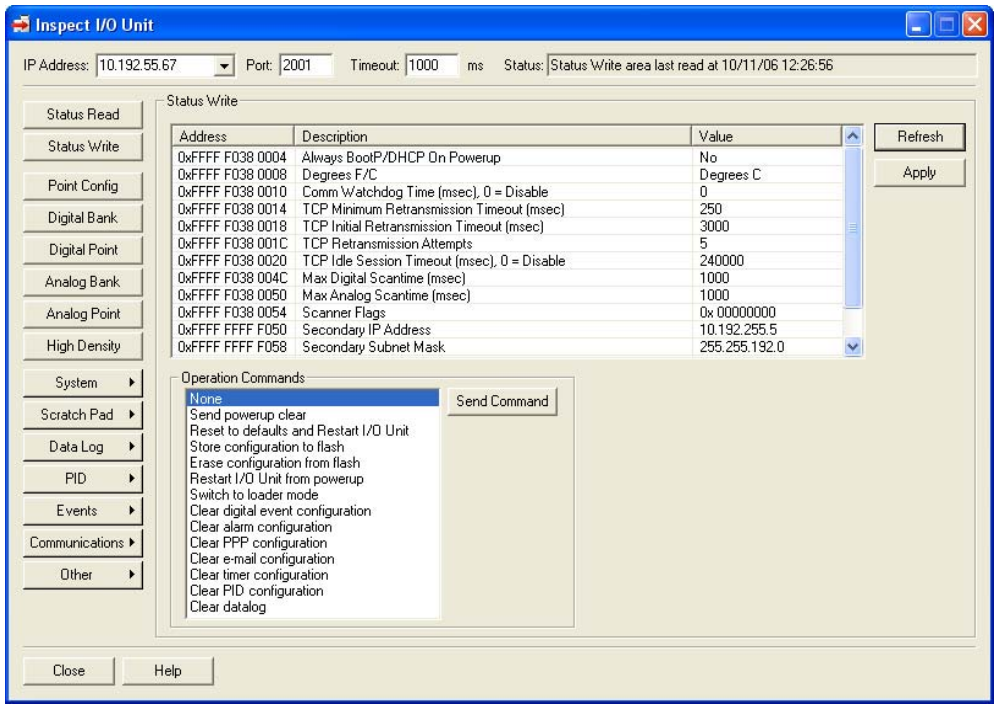
TCP Settings

Retransmit timeout (RTO) refers to the length of time the controller waits while communicating before timing out. The RTO is determined by the controller's TCP/IP stack, and the stack continually recalculates the RTO based on recent network traffic. If the network becomes busier, for example, the stack automatically adjusts the RTO to a higher value.

If the TCP/IP stack times out while trying to transmit data, it doubles the current RTO and tries again. This process continues for five retries; after that, the controller stops trying and sends a timeout message.

If you are receiving frequent timeout messages from the I/O unit, you can change the TCP parameters in PAC Manager.

1. Choose Start→Programs→Opto 22→PAC Project Software→PAC Manager.
2. In the PAC Manager main window, click the Inspect icon .
3. In the IP Address field, type the IP address of the controller. Click Status Write.



CAUTION: *Note the following recommended settings:*

TCP Minimum Retransmission Timeout (msec):	*250*
TCP Initial Retransmission Timeout (msec):	*3000*
TCP Retransmission Attempts:	*5*
TCP Idle Session Timeout (msec):	*240,000*

If you set these fields too low, you may not be able to communicate with the device at all, even through PAC Manager, to fix the settings. Then you would have to reset the controller to factory defaults (see page 42).

4. Change these four fields as necessary:

Minimum RTO sets an absolute minimum value for the RTO. The device's calculated RTO will never go below this value.

Initial RTO sets the RTO for the first communication try. Be careful: since all future tries are based on this value, if you set it too low for network conditions, a connection will never be made.

TCP Retransmits sets the number of times the device retries communication. Larger, busier networks need a higher number of retransmits than smaller networks with less traffic.

TCP idle session timeout sets how long (in milliseconds) the device allows a session to remain open without any activity. After this time, the device checks the session to make sure it is still good, and closes it if it is not. The default is 240,000 milliseconds, or four minutes.

5. Click the Apply button to write your changes to the controller.
6. In the Operation Commands list, highlight Store configuration to flash. Click Send Command.
7. In the Operation Commands list, highlight Restart brain from powerup. Click Send Command.

   The new TCP parameters are set.

Module Troubleshooting: Frequently Asked Questions

Q: I have a SNAP digital module that has ceased to function. What may have caused this?

A: Loss of function in a SNAP digital module is normally caused by misapplication. As with Opto 22's other digital I/O module families, there is no one way in which SNAP I/O modules fail. Output modules normally fail in a different way than inputs.

Output modules usually fail open, or half-wave for AC, and the failure is normally caused by the application of too much current or by degradation of the semiconductor switch by overvoltage.

Because the module is separated into two parts by the optical isolator, it is possible to have an output module that behaves properly on the logic side but is broken on the field side. The LED will in most cases continue to turn on and off as commanded by the driving logic device, even though the module has failed.

The first step to troubleshooting a failed module is to check the fuse. If it is blown, simply replacing it should get the module working again. If the module continues to blow fuses, analyze the load to see if the module is really suitable to the application.

When input modules fail, they usually do so on the field side, typically from overvoltage or overcurrent resulting from overvoltage. Opto 22's SNAP AC and DC input modules contain a full-wave rectifier (as opposed to the G1 and G4 modules, which contain a bridge rectifier), allowing hookup without regard to polarity. Unlike output modules, an input module's LED normally will not function as expected when the module has failed.

Failures on the field side of all types of Opto 22 digital I/O modules occur extremely rarely and are typically the result of misapplication. The logic-side failures of Opto 22's I/O modules are also extremely rare. Usually, a failure of the logic side is attributable to using the module at the wrong logic voltage or to miswiring.

Q: I have an input module that seems to "flicker" when a voltage is applied to it. What is happening here?

A: Opto 22's basic input modules contain full-wave rectifiers. In an AC application it is possible to destroy one-half of the rectifier and still have the module function after a fashion. The full-wave rectifier turns into a half-wave rectifier, causing the module to turn on and off at the line frequency when an input is applied. This may be seen visibly as "flicker" on the channel status LED.

Digital logic devices, having much faster detection times than the human eye, can have serious problems with this failure mode. For example, a digital counter attached to a failed module will count at the input frequency.

This failure occurs most commonly in applications where the input module is placed in parallel with an inductive load. When the load turns off, the back-EMF goes right through the module, destroying one-half of the bridge.

Placing a transorb or large R-C snubber in parallel with both the load and input module will significantly reduce the frequency of, or eliminate entirely, this type of failure.

Q: I have an output module driving a load. The load turns on okay but never seems to turn off, unless I remove power from the relay entirely. What might be happening?

A: This problem may occur when using an output module with a high-impedance load, such as a neon lamp or a small solenoid. Loads like these often have relatively large initial currents but relatively small "hold-in" currents. The result is that the off-state leakage current through the module is insufficient to cause the load to turn on to start with, but sufficient to keep it on once started.

The solution to this problem is to place a power resistor, sized for 8–10 times the rated maximum leakage current for the module, in parallel with the load. Make sure that this resistor has a high enough power rating for the application.

Q: I have a new AC output driving a solenoid. It turns on okay once, but will not turn on again. What is going on?

A: Some solenoids and some types of halogen lights incorporate a diode in series with the coil or filament. This causes the light to behave as a half-wave rectifier. Opto 22 output modules have a built-in R-C snubber circuit in parallel with the output. The capacitor in this circuit charges up but cannot discharge through the series diode, causing a voltage to appear across the output terminals. Because the module must see a zero voltage across the terminals to come on, it can't turn on again in this situation.

The solution is to find a lamp or solenoid that does not have an internal diode; a potential work-around would be to put a high-value resistor (several tens of KOhms) across the output terminals of the module, to allow the capacitor to drain its charge.

Q: I have an AC output module in a circuit, wired in series (ANDed) with another contact. When that other contact closes, my load turns on momentarily, even though my output module is off. Is my module broken?

A: This situation arises when the output module does not see a voltage across its terminals. This occurs when another contact is wired in series with the module, between the module and the "hot" side of the supply. Because the module is totally isolated from field to logic, the field (or contact) side of the module must power itself from the attached line. By nature of the pilot circuit in the module, the switching semiconductor is in an indeterminate state when there is no voltage across the module. It may turn on for up to a half cycle if it is suddenly "wet." The pilot circuit will realize that the module is on, but it cannot turn it off until the voltage crosses zero again.

There is no easy solution to this problem. Typically a solution will involve either maintaining a minimal voltage across the module, pre-wetting it with a low voltage, or absorbing the energy from the half-cycle turn-on with an R-C network in parallel with the load.

Q: Why are all four loads connected to my SNAP output module coming on when I'm activating only one of the channels?

A: The SNAP digital output is likely connected on the wrong side of the loads. Remember that all four channels share one fuse; thus one side of each output is common with one side of all the others. If the module is on the wrong side of the load, any one channel is effectively connected to all four. If the output is a SNK type, try switching to a SRC type. In AC applications, reverse the module wiring.

Q: I keep having failures on one channel of my SNAP output module. Why might this be happening?

A: Failures of only one of the four output channels would indicate a problem with the load being driven by that channel. Make sure that the load characteristics, including transient characteristics, do not exceed the capabilities of the module. Also be sure that the module is properly transient protected, using either an R-C snubber (AC) or a commutating diode (DC) across the load. Modules may also be protected through the use of transient voltage suppressors across the module itself.

SNAP Analog Troubleshooting

SNAP analog modules require a fairly substantial amount of current due to their on-board isolation power inverters. Because of this, it is important to make certain that the entire SNAP installation is supplied with 5.0 to 5.2 V, even while under full load.

Insufficient power supply could cause symptoms ranging from module "drift" to random resets and communication problems on the brain. The SNAP equipment is designed with a fail-safe voltage watchdog feature that inhibits operation when power supply voltage levels get too low, thus eliminating the possibility of unintentional output or input. Opto 22 offers DIN-rail-mountable power supplies for use with SNAP I/O systems.

Keep in mind that unless you purchase an isolated module, the channels on a SNAP input or output module are not isolated from one another. Make certain that any transducers or equipment that these modules are used with are floating, isolated from local earth ground. If the equipment is not floating, make certain that the two pieces of equipment being connected are at the same ground potential in order to eliminate the possibility of a ground loop through the module. A ground loop through the module could result in almost anything, from inaccurate readings to catastrophic failure of the module.

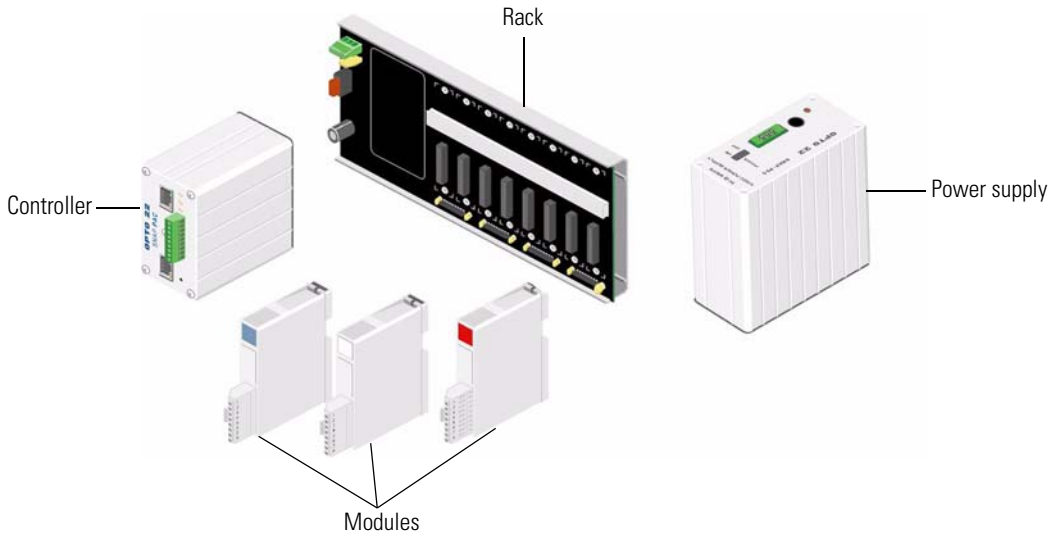
SNAP analog modules, like any high-level electronics, require protection from electrical noise in high-noise environments, such as installations near arc or plasma equipment or AC inverters. If the SNAP analog system is to be installed in such an environment, be certain that the system is enclosed in an appropriate enclosure. Opto 22 has several documents available that discuss grounding and shielding practice, noise mitigation, and electromagnetic compatibility:

- Grounding, Shielding, Noise, and Compatibility (Opto 22 form #TN9603)
- Grounding and Wiring Practices (form #TN9603A)
- Operational Interferences and Noise (form #TN9603B)
- Interference Generation and Compatibility (form #TN9603C)

SNAP Mounting Racks and Power Supplies

Introduction

As shown in the illustration below, a SNAP PAC R-series I/O system has a SNAP PAC R-series controller, SNAP PAC rack, power supply, and modules. This appendix includes wiring diagram examples for assembling your SNAP PAC R-series controller, SNAP PAC rack and power supply. For more information, especially for information on modules, see the data sheet and the installation or user's guide for your specific products.



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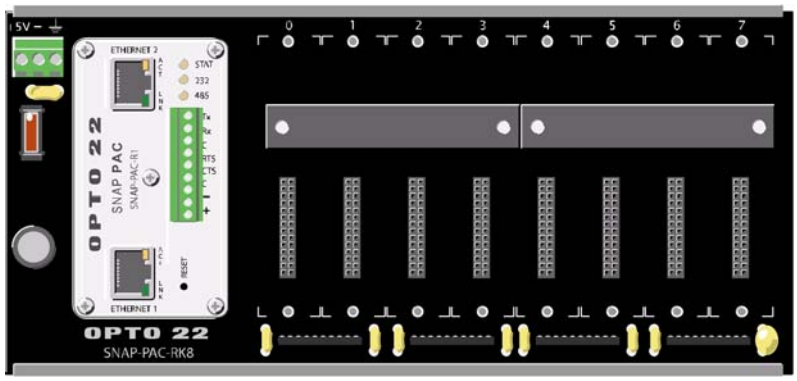
SNAP Mounting Racks

SNAP mounting racks can hold an I/O processor (brain or rack-mounted controller) and up to 4, 8, 12, or 16 SNAP modules. A SNAP PAC rack is shown below with a SNAP PAC R-series controller installed, but no modules. All wiring connections are made to the field connectors on the top of each module.



SNAP Power Supplies

Primary Power Supply

NOTE: For a more general discussion of using power supplies with Opto 22 systems, see Opto 22 form #1271, a technical note available on our website at www.opto22.com.

SNAP PAC racks use a 5 VDC power source (5 VDC [-0.0, +0.1] at minimum 4.0 Amps recommended). For systems using AC source voltage, the SNAP-PS5 or SNAP-PS5U power supply is recommended. For DC systems, such as those using DC backup power, the SNAP-PS5-24DC offers DC-to-DC power.

In general, we recommend you **use an independent, isolated, regulated power supply locally with each rack**. Local isolated supplies offer these advantages:

- Short supply conductors, which minimize losses
- Power redundancy, so the failure of a single supply causes only a single rack failure, not a total system failure
- Fewer voltage drops and ground loops. (Voltage drops and subsequent ground loops may occur when power is distributed over a large system.)

Always **use a separate power supply for the field side of the I/O**. Using the rack supply for field actuation and monitoring defeats the isolation the I/O module offers and therefore increases the chance of a ground loop within the control system. Additionally, a sudden change of current on the field side can cause undesirable voltage fluctuations that may interfere with the computer's operation.

Determining Power Requirements

Both the SNAP-PS5 and the SNAP-PS5-24DC power supplies provide 5 VDC power for loads up to 4 Amps. The SNAP-PS5U provides 5 VDC for loads up to 5 Amps. In most cases this power is sufficient for a SNAP processor, a rack, and the associated I/O modules. However, some combinations of modules, especially special-purpose modules, may require additional power. You can use the following table to help determine power needs for your I/O units.

Item	Quantity	X Power Req. (Amps)	Total Power Required (Amps)*
SNAP PAC R-series controller	1	1.200	1.200
SNAP-IDC5-SW digital input module SNAP-IDC5-SW-NC digital input module SNAP-AITM-8 analog input module Isolated analog input and output modules (part numbers ending in -i or iSRC)		0.200	
All other 4-channel digital input and output modules (*not* high-density digital modules)		0.050	
SNAP-AICTD analog input module SNAP-AICTD-4 analog input module High-density digital input and output modules SNAP-AIMA-32 and SNAP-AIV-32 analog input modules All analog output modules except SNAP-AOA-iSRC		0.150	
SNAP-AIARMS analog input module SNAP-AIVRMS analog input module SNAP-AIMA and AIMA-4 analog input modules SNAP-AITM and AITM-2 analog input modules SNAP-AIMV-4 and AIMV2-4 analog input modules SNAP-AIV and AIV-4 analog input modules		0.170	
SNAP-AIRTD analog input module SNAP-AIR40K-4 analog input module SNAP-AIRATE analog input module		0.190	
SNAP-AIPM power monitoring module		0.100	
SNAP-AILC and AILC-2 load cell modules		0.120	
Serial communication and Profibus modules Motion control module *not* powering a breakout board		0.250	
Motion control module powering a breakout board		0.700	
Total			

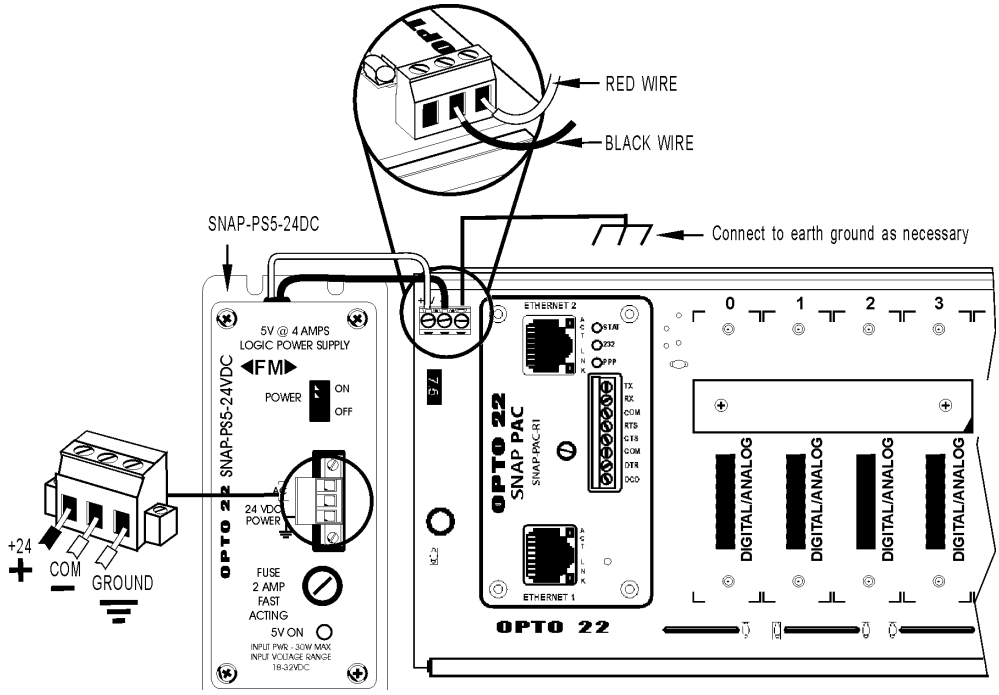
* Current from 5-volt supply

IMPORTANT: For a SNAP-PS5 or a SNAP-PS5-24DC power supply, the total power required must not exceed 4 Amps. For a SNAP-PS5U, the total power required must not exceed 5 Amps.

Wiring the Primary Power Supply

Use one power supply per I/O unit. Use 14 AWG wire.

1. Mount the SNAP-PS5 or SNAP-PS5-24DC power supply so that the attached red and black power wires will reach the + and – power terminals on the SNAP mounting rack.
2. Using the power terminals on the SNAP mounting rack, attach the red wire to the + terminal and the black wire to the – terminal. Connect the ground terminal on the SNAP rack to ground.
3. For the SNAP-PS5 (not illustrated): Using the removable input power connector on top of the power supply, apply 120 volts AC power between the two terminals marked "AC." Connect the ground terminal to ground.
4. For the SNAP-PS5U (not illustrated): Using the removable input power connector on top of the power supply, apply 240 or 120 volts AC power between the two terminals marked "AC." Connect the ground terminal to ground.
5. For the SNAP-PS5-24DC (illustrated below): Using the removable input power connector on top of the power supply, apply 24 volts DC power between the two terminals marked "±DC." Connect the ground terminal to ground.



Loop Power Supply

Some analog modules (SNAP-AIMA, SNAP-AIMA-4, SNAP-AIMA-i, SNAP-AIMA2-i) also require a current loop supply, which can be provided by the SNAP-PS24 or the SNAP-PS24U. Both offer 24 volts of DC power, the SNAP-PS24 at .75 A and the SNAP-PS24U at 1.25 A. Follow these steps to wire these power supplies.

1. Mount the SNAP-PS24 or SNAP-PS24U power supply in a location where the attached output power wires will reach the field connector for SNAP analog modules.

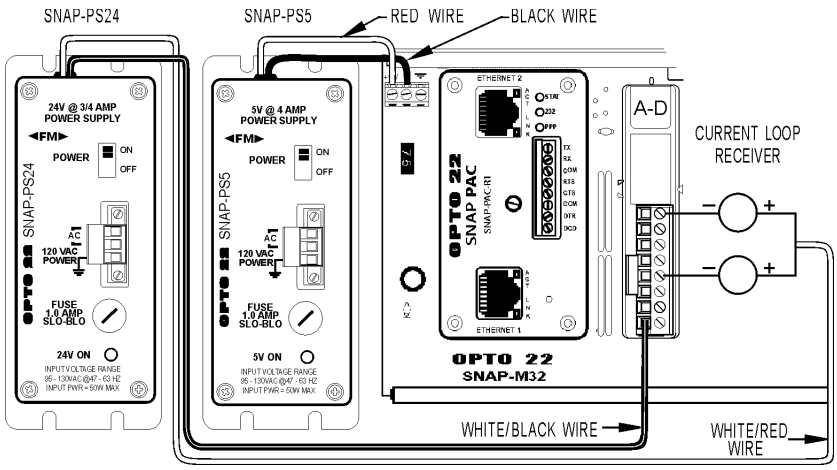
The white and red wire is the positive wire (24 VDC). The white and black wire is the negative wire (24 VDC return).

2. If you are wiring directly to the module, see the wiring diagram for the specific module you are using.

Examples for an input module are shown in the following diagrams.

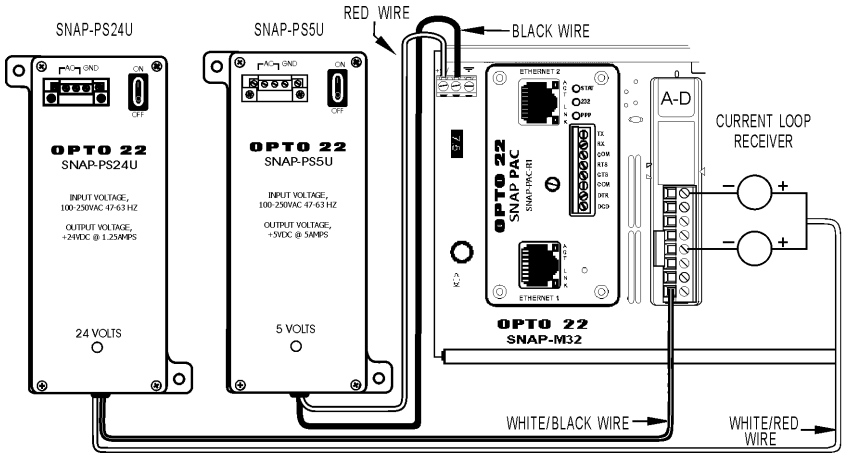
SNAP-PS24

In this diagram, the SNAP-PS24 power supply supplies power directly to the input module. The SNAP-PS5 supplies power to the rack.



SNAP-PS24U

Here, the SNAP-PS24U power supply supplies power directly to the input module. The SNAP-PS5U supplies power to the rack.



Installing the Controller and Modules

For instructions on installing the controller, see "Installation" on page 7. For information on modules, see the module datasheets available at our website, www.opto22.com.

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